SUMMARY OF SPRING CLASSIFICATION SURVEYS OF THE BATHURST CARIBOU HERD 1985-1995

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SUMMARY OF SPRING CLASSIFICATION SURVEYS OF THE BATHURST CARIBOU HERD 1985-1995

T. MARK WILLIAMS

AND

BONNIE FOURNIER

DEPARTMENT OF RESOURCES, WILDLIFE AND ECONOMIC DEVELOPMENT

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ABSTRACT

This report summarizes the results of ten classification Bathurst caribou herd surveys conducted by the Department of Renewable Resources in 1985, 1987-1989, and 1991-1995. Classification surveys were used to estimate calf survival in the Bathurst caribou herd, to aid in understanding the herds population dynamics and to understand the interaction of the caribou with the Echo Bay winter road to Contwoyto.

Distributions of caribou were determined by reconnaissance flights. Caribou were approached by snowmobile and on foot, then classified into age groups with the use of a spotting scope. Prior to 1988, cluster samples were used to estimate age and sex ratios, then the jackknife method was used to avoid any assumptions of normality of data. Calf production and overwinter survival were ascertained by calculating the percent increase in herd size from reproduction.

In 1985, 1989, 1990, 1992, and 1994, calf production and/or overwinter calf survival fell below the average for the ten years the surveys were conducted. Calf production and/or overwinter calf survival was very good in 1991, 1993, and 1995.

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INTRODUCTION

The Department of Renewable Resources in 1985, 1987-89 and 1991-95 undertook late winter classification surveys to estimate calf survival in the Bathurst caribou herd. Those 10 surveys had been reported to the communities but the results were scattered in a number of files. This report is a compilation of these community reports and includes distribution maps. To aid any interpretation of the distribution, we have also included maps showing the flight lines.

The proportion of offspring in herd composition counts provides a useful measure of annual recruitment where assumptions that 1) female recruitment and mortality are relatively stable as compared to male recruitment and mortality and 2) that female mortality is small relative to offspring mortality are valid (McCullough 1994). In those situations juvenile/offspring ratios can serve as an index of recruitment and may be highly correlated with rates of population change (Krebs et al. 1986).

While recognizing the biases inherent in any change in ratio method, because of characteristics of age specific fecundity and age structure in mainland caribou populations, selectivity of wolf predation towards calves, and relative lack of selectivity of human hunting for cows, large changes in calf: cow ratios most likely reflect change in calf survival rates, which have the greatest effect on population growth rates. Therefore annual measures of the ratio of calves to cows in migratory mainland herds are expected to provide a useful index of recruitment, that correlate with herd growth,

and provide a relatively inexpensive measure upon which to base predictions of change in herd size between population estimates.

Calf : cow ratios alone do not provide a good measure upon which to predict change in population size (no change in calf : cow ratios could indicate that the population is stable, declining at a constant rate, increasing at a constant rate, or declining at a variable rate under the influence of hunting (Caughley pers. comm.), therefore independent assessments of population size are required to validate demographic changes as indicated by composition counts (Caughley 1974 and McCullough 1977 in McCullough 1994). Renewable Resources obtains independent estimates of population size at regular intervals with estimates of the number of breeding females on calving grounds, or total population estimates from total counts of post-calving aggregations. The importance of the information is not only in understanding the Bathurst herd's population dynamics but also in considering the interaction of caribou with the Echo Bay winter road to Contwoyto Lake. The compilation of late winter distribution is summarized relative to the route of the winter road (Figure 1).

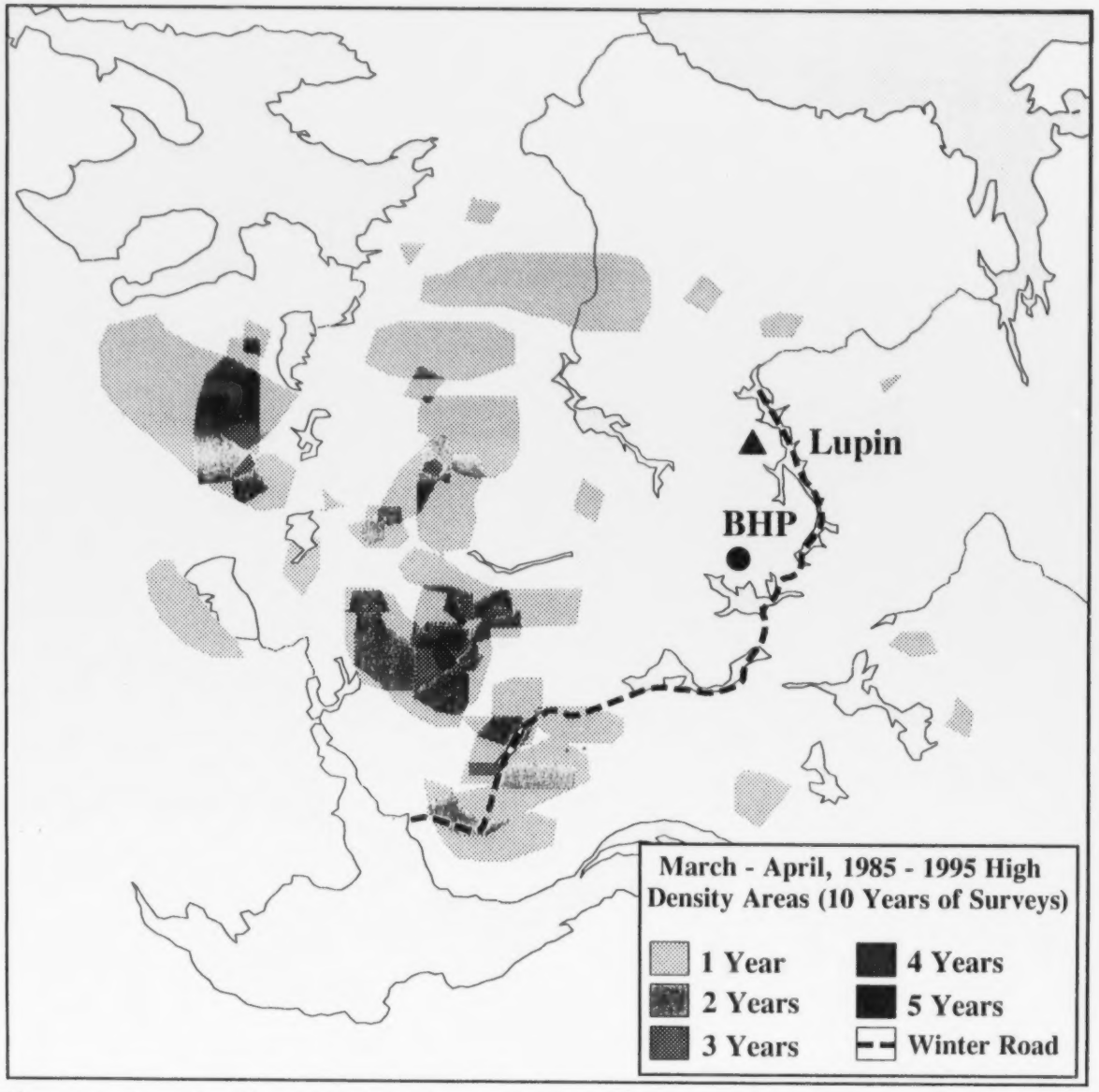

Figure 1. Bathurst caribou late winter distribution relative to the Echo Bay winter road, 1985 - 1995.

METHODS

Prior to each survey the distribution of Bathurst caribou was determined from reconnaissance flights over forested areas of Bathurst range (Figure 2) using a Cessna 337. The 337 was operated by Landa Aviation and was based out of Yellowknife for the duration of the contract (Figures 3 - 12). Reports of caribou sightings from pilots, hunters and truck drivers were useful to determine initial aerial reconnaissance. From 1985 to 1990, a fixed wing aircraft (DeHavilland Turbo Beaver in 1985, Cessna 185 in other years) was used to position Renewable Resources personnel close to groups of caribou. The caribou were then approached on foot and were viewed with a 25 power spotting scope. Snowmachines were also used to approach caribou aggregations. After 1990, caribou were classified from the air using a Bell 206B helicopter. In all years, classifications were recorded on magnetic tape to be transferred later to a notebook.

Unless a penis was visible, sex identification was based on the presence or absence of a darkened vulval patch. Age categories were calves (10 month old animals), yearlings (22 month old animals), cows, young bulls and mature bulls. Calves were distinguished by their small body size and relatively short, rounded face. Yearlings were intermediate-sized animals with a straight face profile. Young bulls were small-bodied males with at least one hard antler, while adult bulls were larger and without antlers.

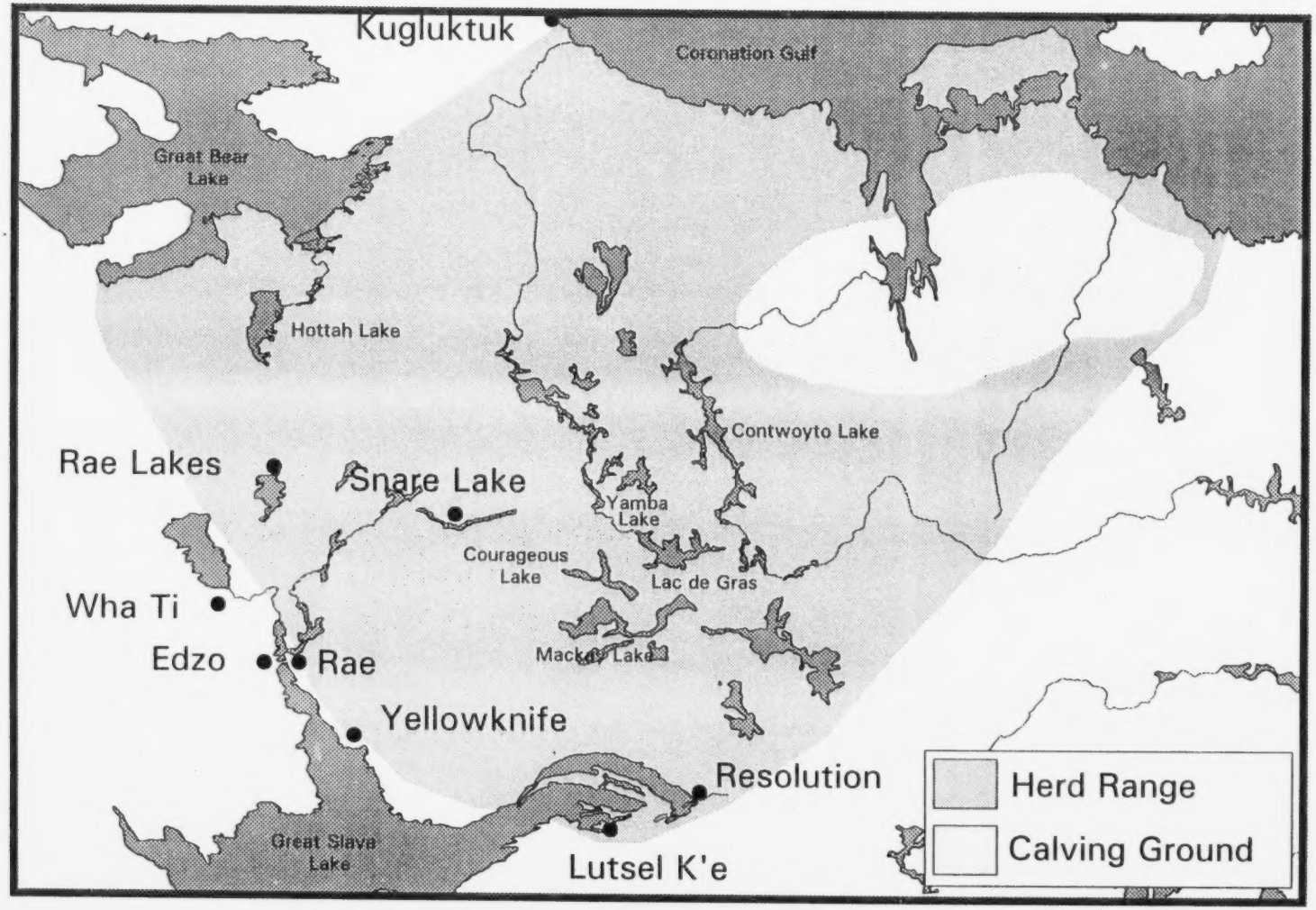

Figure 2. The Bathurst caribou range.

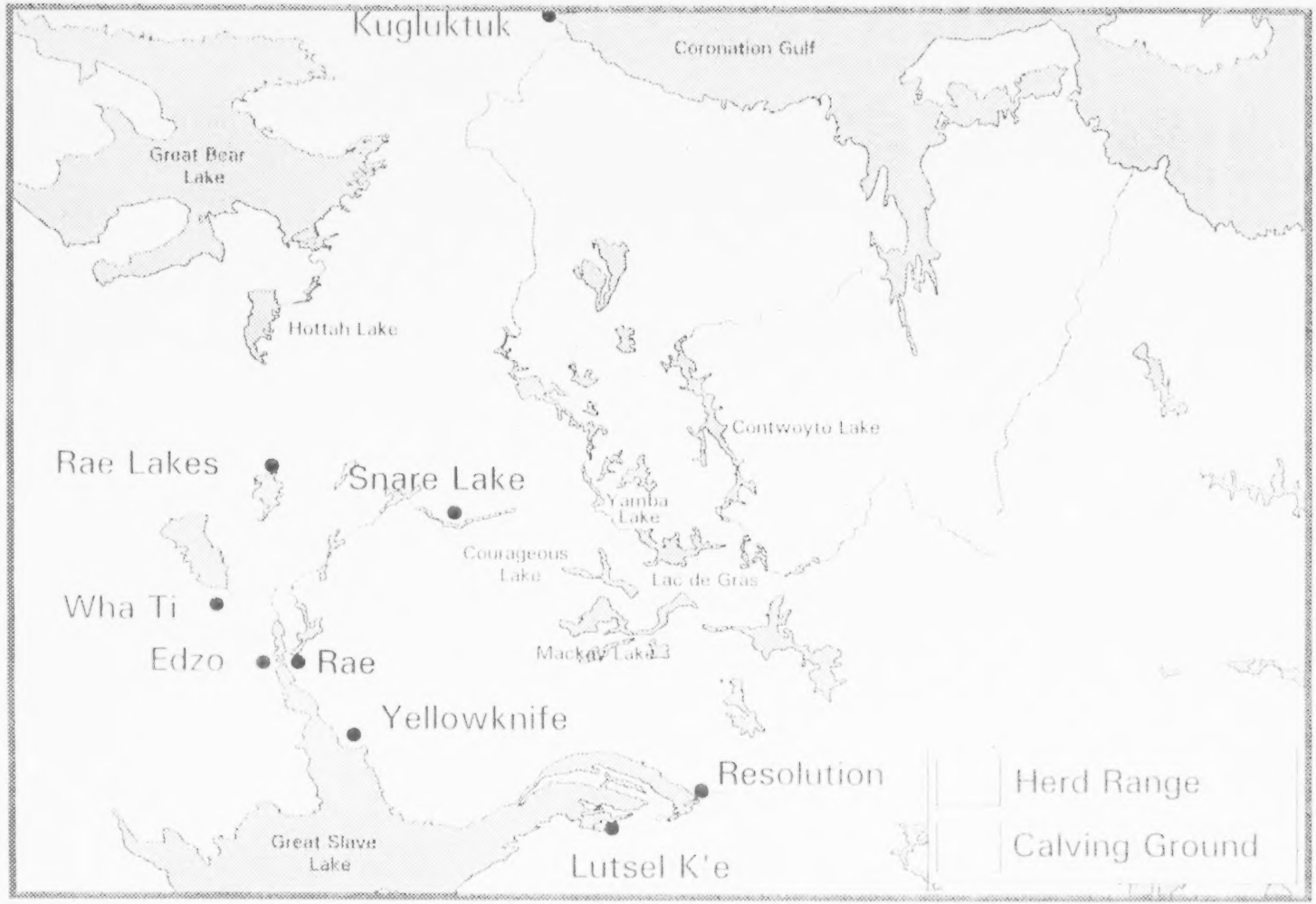

Figure 2. The Bathurst caribou range.

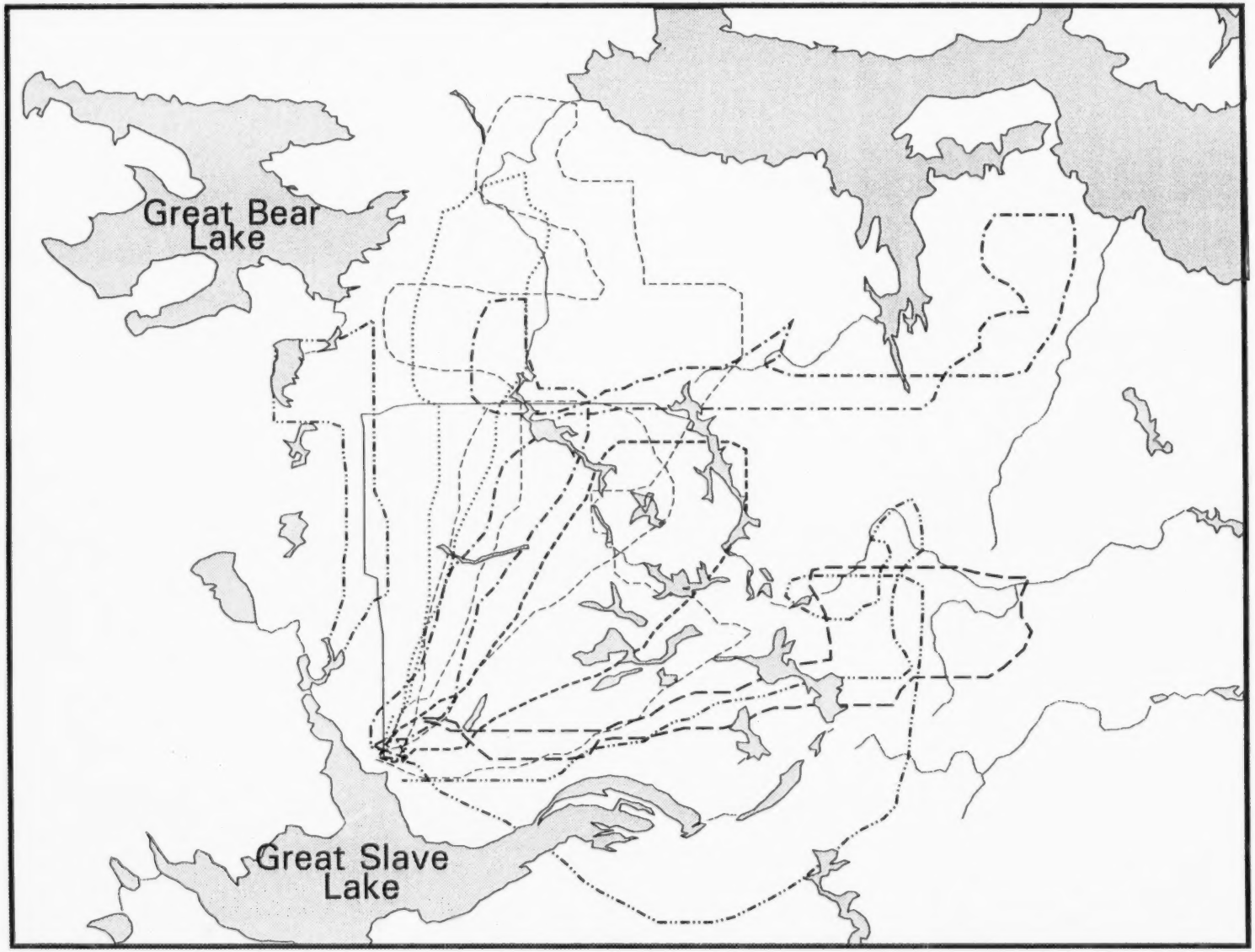

Figure 3. Reconnaissance flights over the Bathurst caribou range 9 - 24 April 1985.

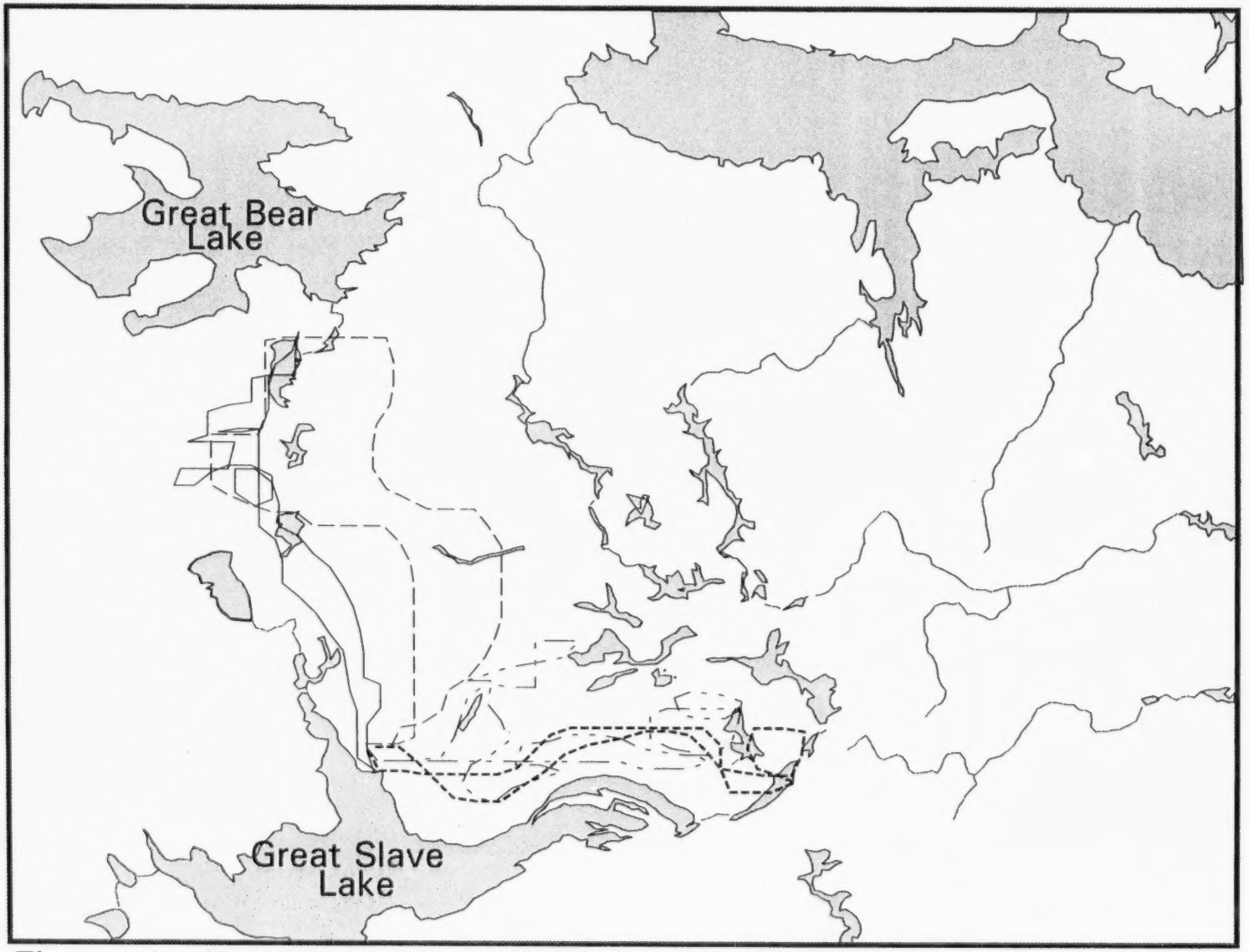

Figure 4. Reconnaissance flights over the Bathurst caribou range March 1987.

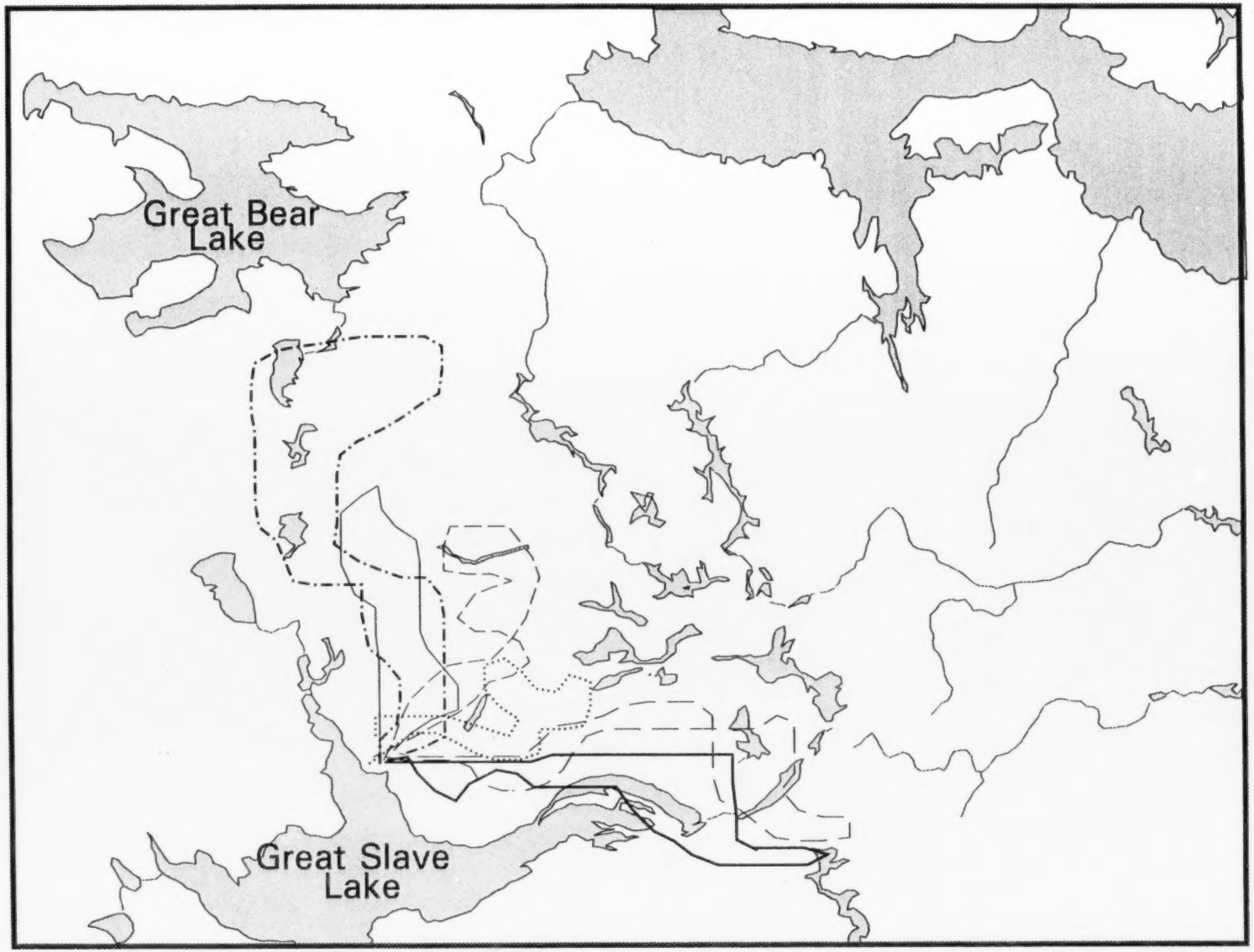

Figure 5. Reconnaissance flights over the Bathurst caribou range March 1988.

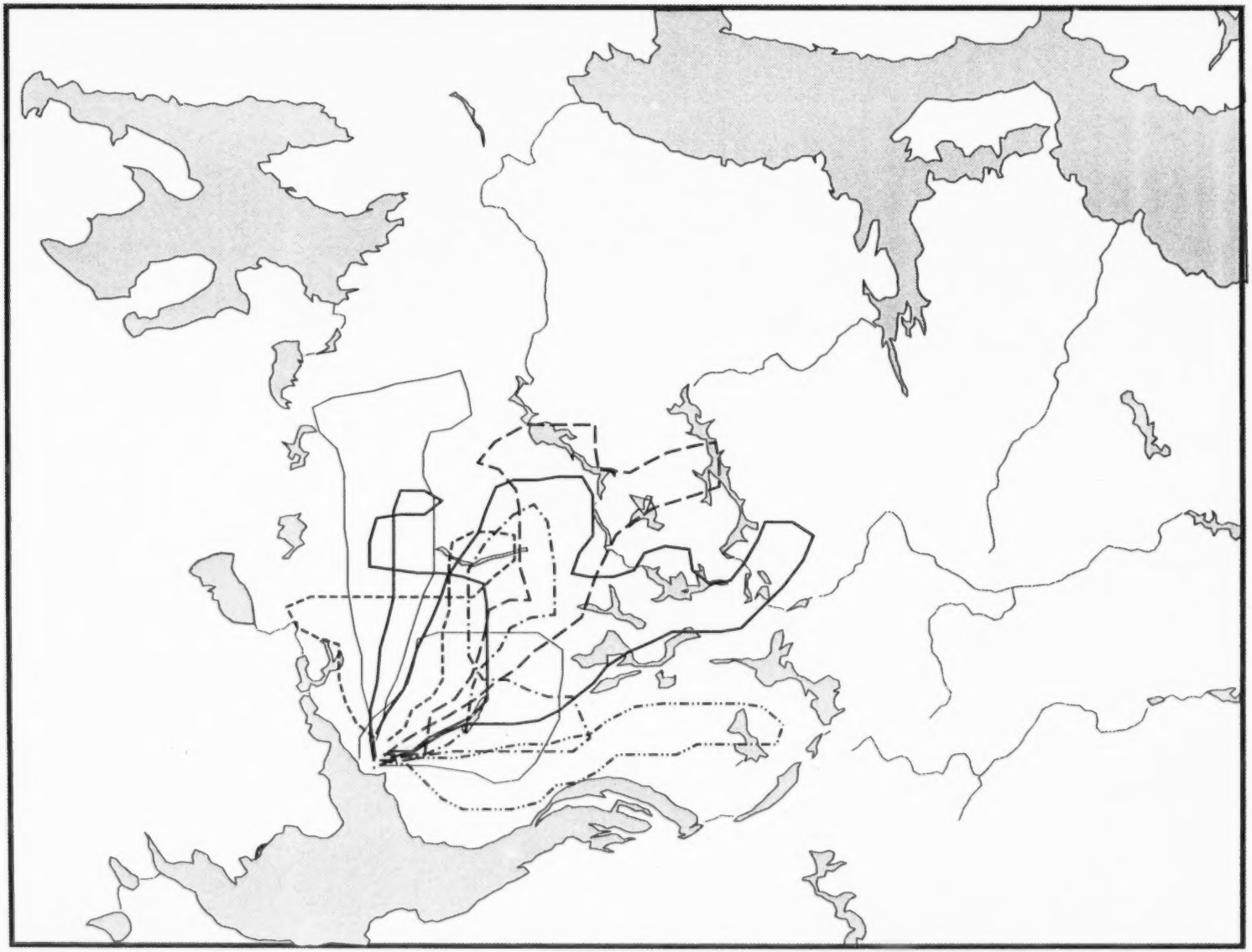

Figure 6. Reconnaissance flights over the Bathurst caribou range March 1989.

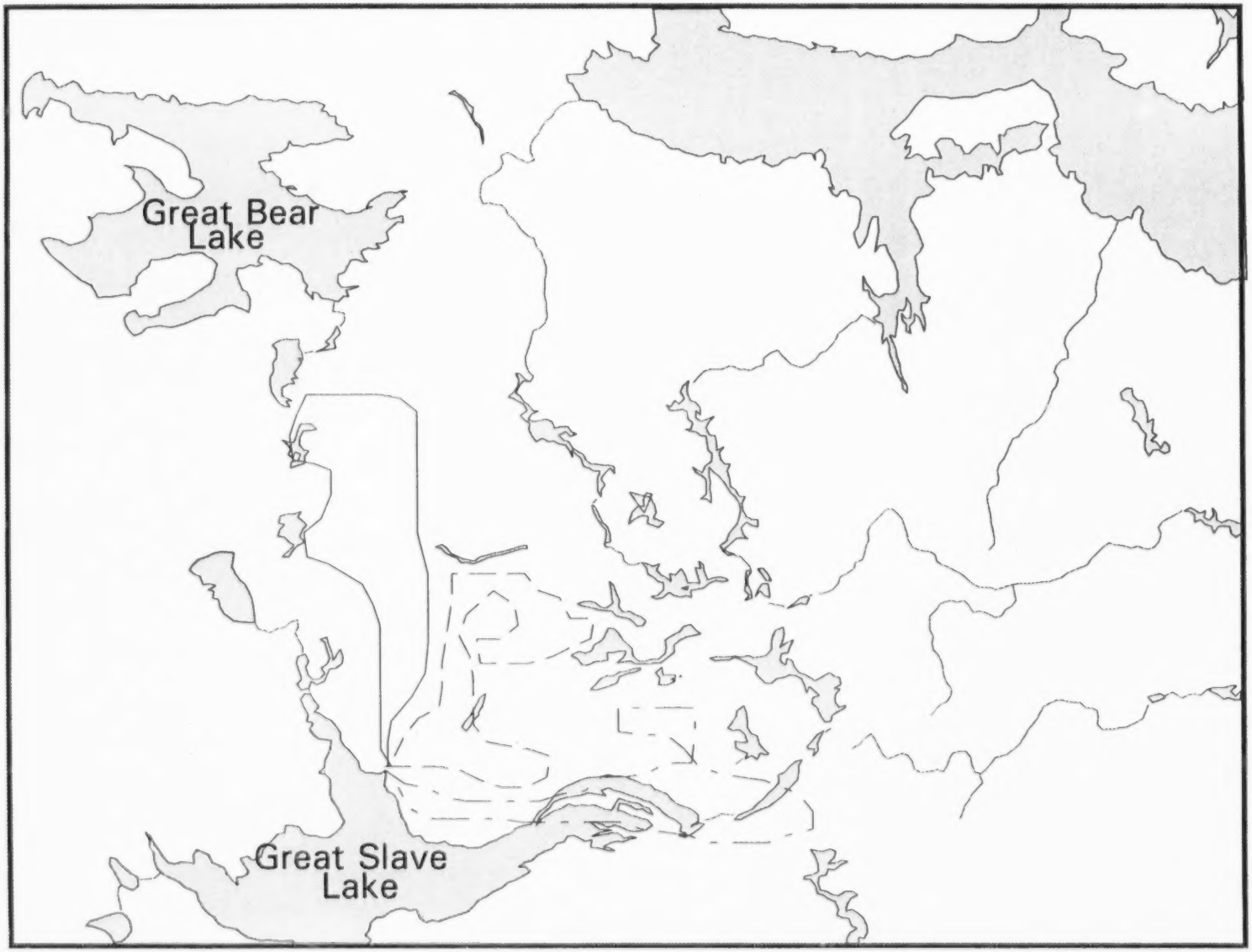

Figure 7. Reconnaissance flights over the Bathurst caribou range March 1990.

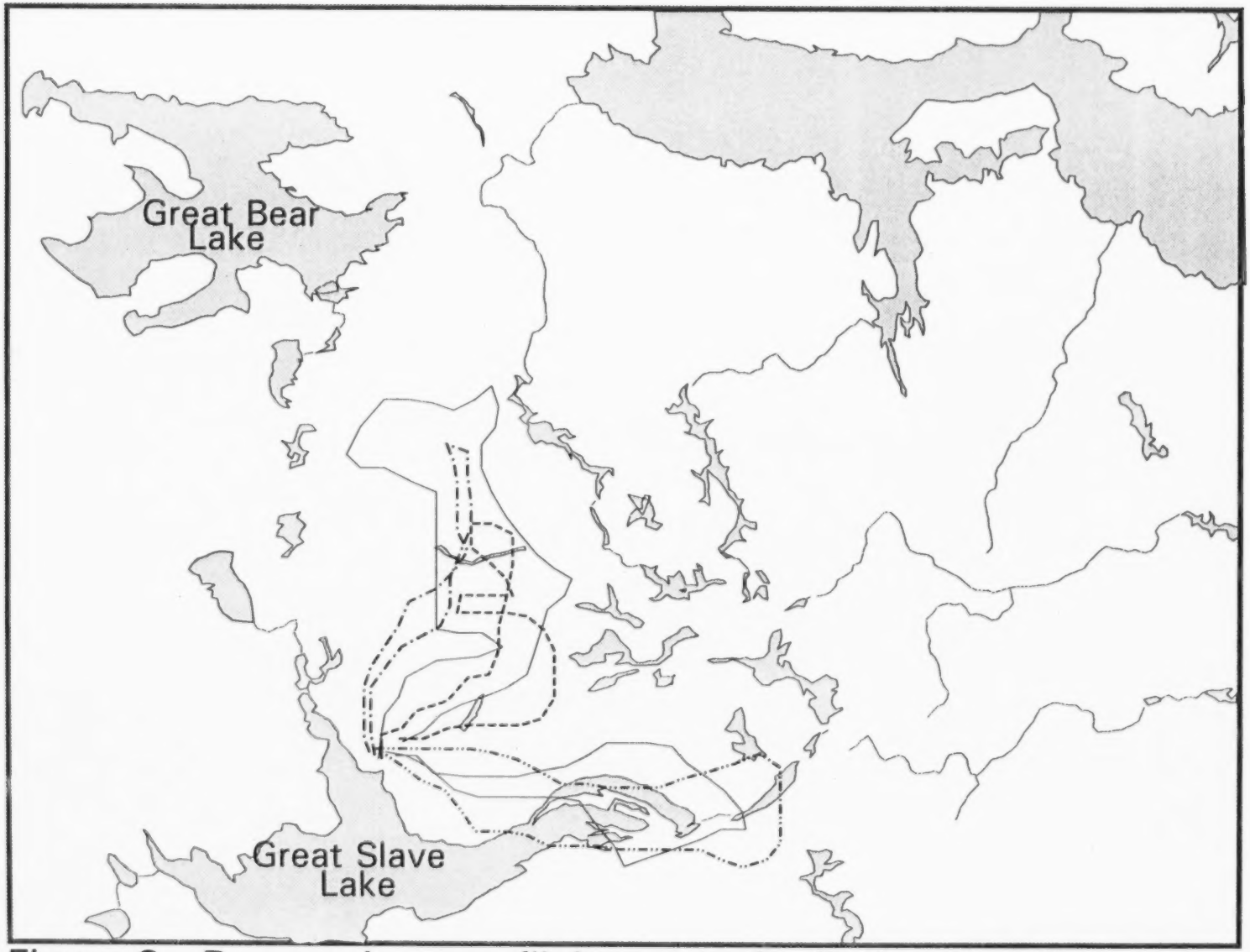

Figure 8. Reconnaissance flights over the Bathurst caribou range 28 February - 24 March 1991.

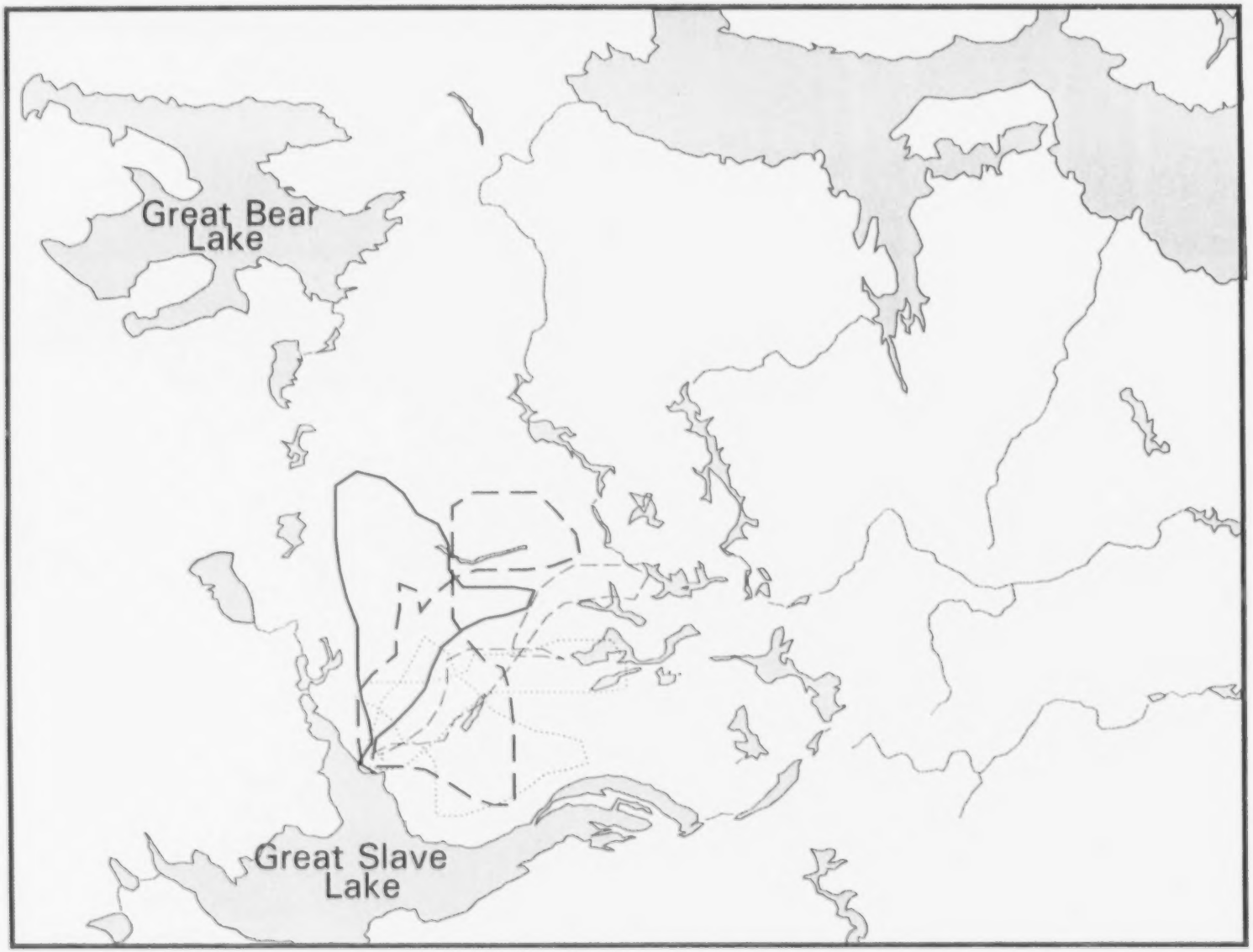

Figure 9. Reconnaissance flights over the Bathurst caribou range 13 - 19 March 1992.

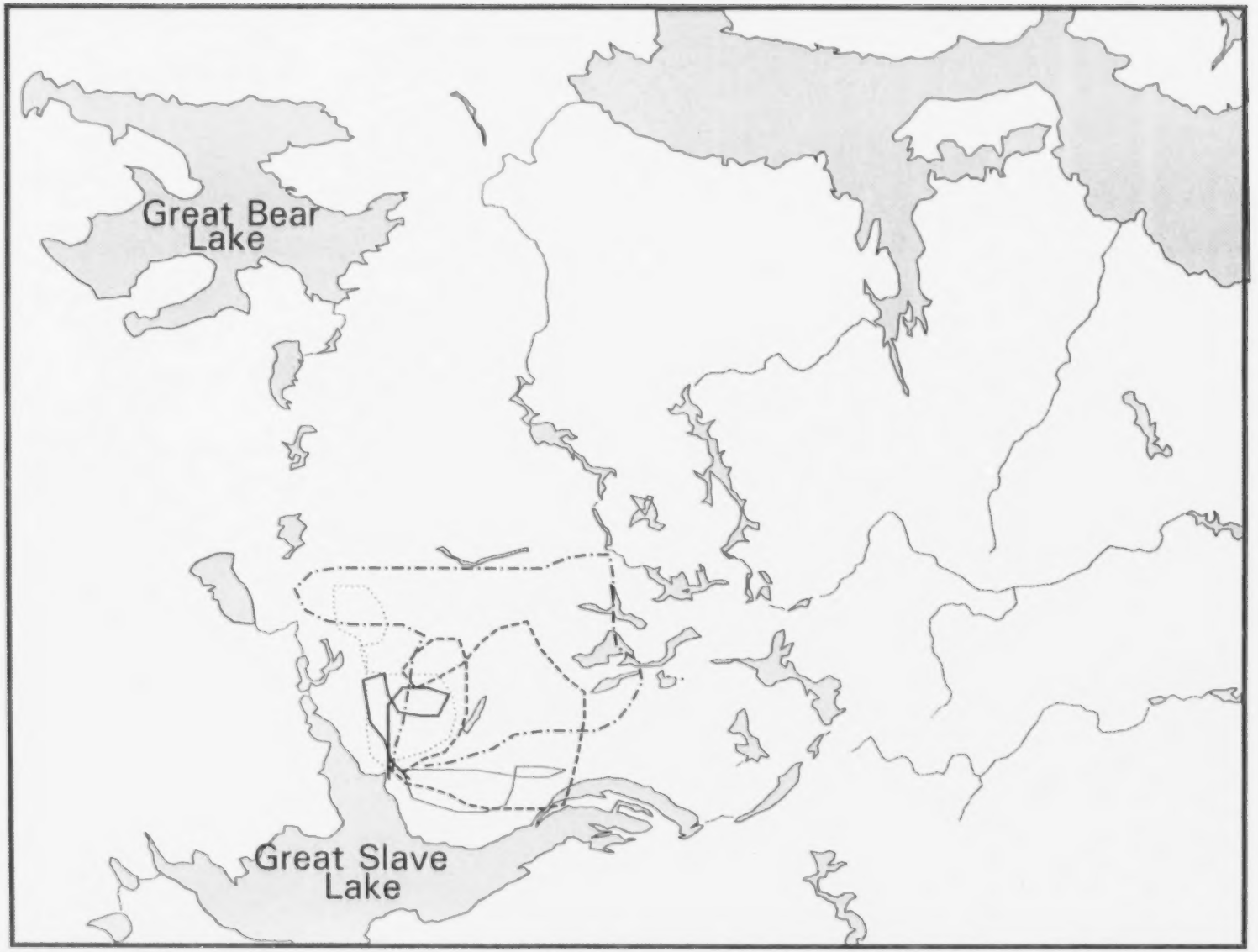

Figure 10. Reconnaissance flights over the Bathurst caribou range 12 February - 11 March 1993.

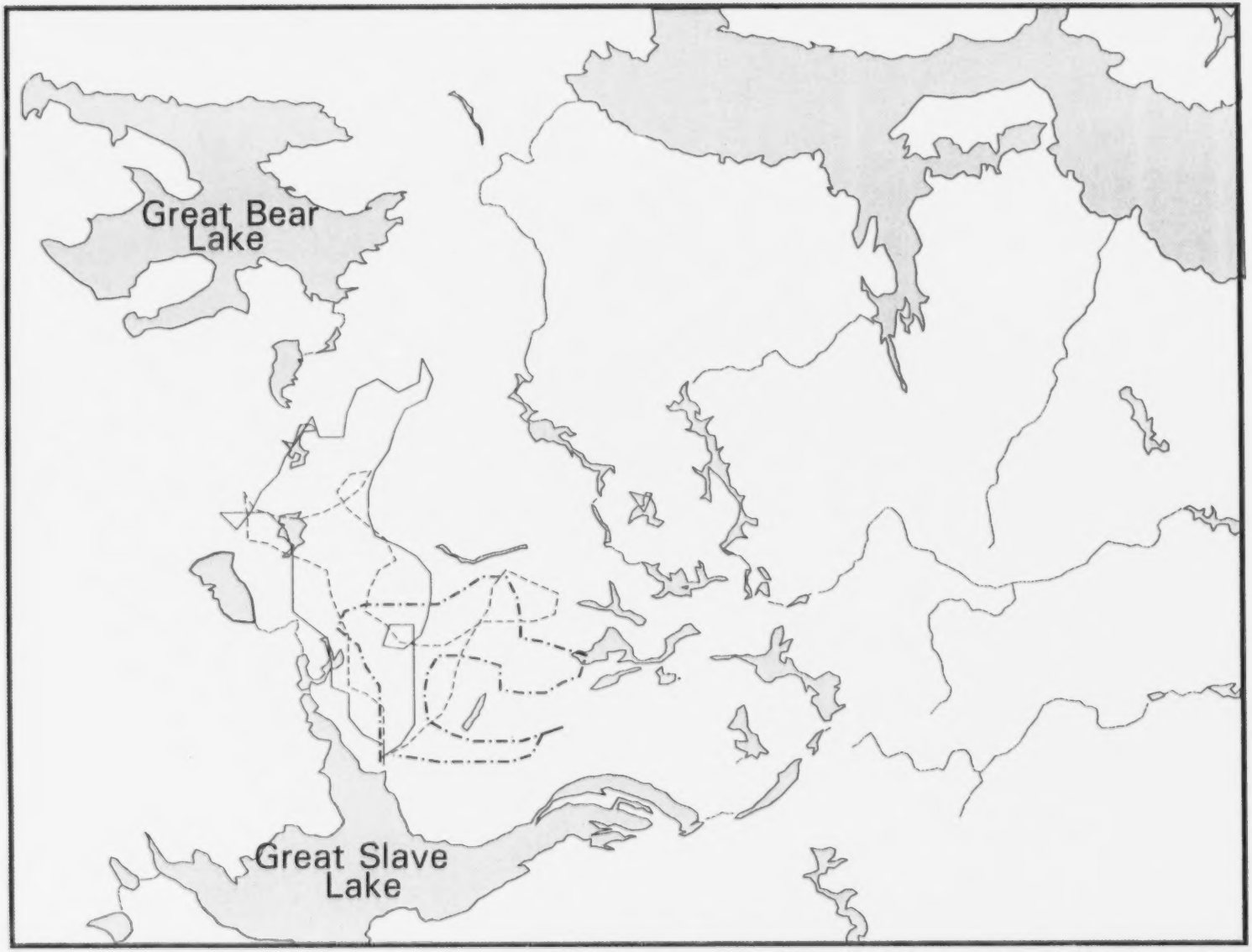

Figure 11. Reconnaissance flights over the Bathurst caribou range 7 - 10 March 1994.

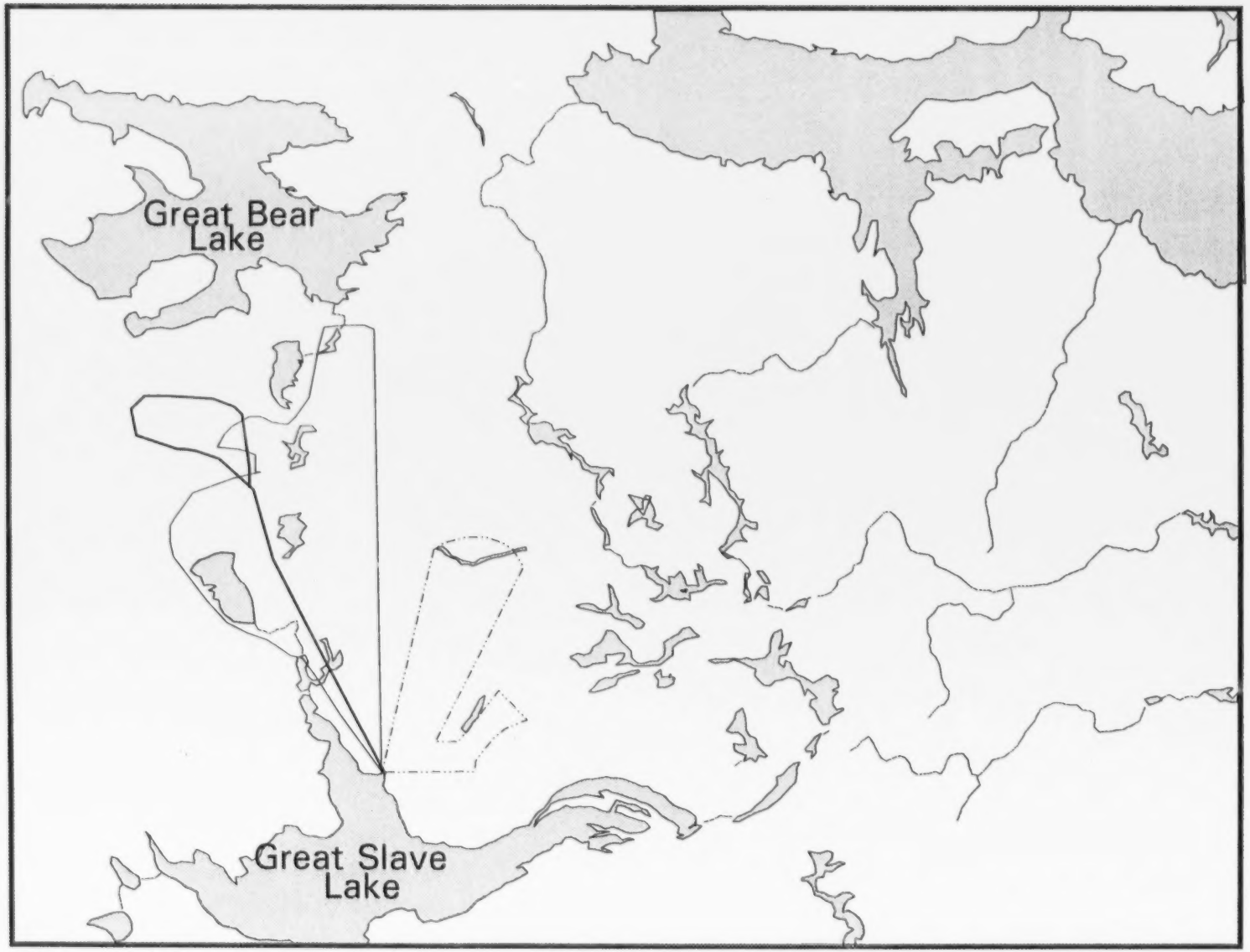

Figure 12. Reconnaissance flights over the Bathurst caribou range 27 - 28 March 1995.

In 1984, 1985, and 1987 classifications were determined using a cluster sampling technique (Cochran 1977:233, 249) and age and sex ratios were calculated using Cochran's ratio estimator formula (Cochran 1977:155, formula 6.13). This technique involved changing sampling areas daily and selecting groups arbitrarily. Animals classified at each site were treated as an independent cluster. After 1987, age ratios and associated variance were determined using the jackknife method (Cochran 1977: 175) in order to avoid assumptions about normality of the data.

Between 1985 and 1989, the calculation of percent calves in the population was based on an adult sex ratio of 61 1+ (over one year old) males: 100 1+ females from Gunn's (1984) fall 1982 estimate for the Beverly herd. After 1990, this estimate was calculated assuming an adult sex ratio of 66:100, the mean ratio from six fall composition surveys conducted on the ranges of the Bluenose (n=1), Beverly (n=4) and Kaminuriak (n=1) herds between 1968 and 1982. Using these assumptions, the unrepresented male segments were added to the observed male: female ratio used in the calculations of percent calves and recruitment rates (Appendix A).

Increment was considered to be the percent increase in herd size from reproduction. For example, if calves are estimated to make up 25% of the population, in a sample of 200 animals, 50 are calves and 150 are animals from other age classes. Therefore % increase in herd size from reproduction is (50/150) X 100, or 33%.

RESULTS

1985 Distribution and Composition

Between 9 and 12 April, 1985 the largest aggregation of caribou was along the tree line north of Rocknest Lake with a lower density spur running west to within 80 km of Great Bear Lake. A few small, scattered groups of caribou were observed east of McTavish Arm, Great Bear Lake, and several groups were north and east of the big bend on the Coppermine River and north and east of Clinton-Colden and Ptarmigan lakes (Figure 13).

A total of 1,539 caribou were classified from three groups between 17 and 20 April, 1985 (Appendix B). There were 36 ± 15.6 (SD) calves for every 100 cows and female yearlings, or 23% calves in the sample. Adjusting for the observed sex ratio of 24 bulls for every 100 cows, the proportion of calves in the population was estimated at 18%, an increment of 22% (Table 1).

Wolf and wolf-kill sighting rates

Although no wolves were observed, two locations where wolves had killed caribou were seen in 49.5 hours flown, for sighting index of 40 kills/1,000 hours (Table 2).

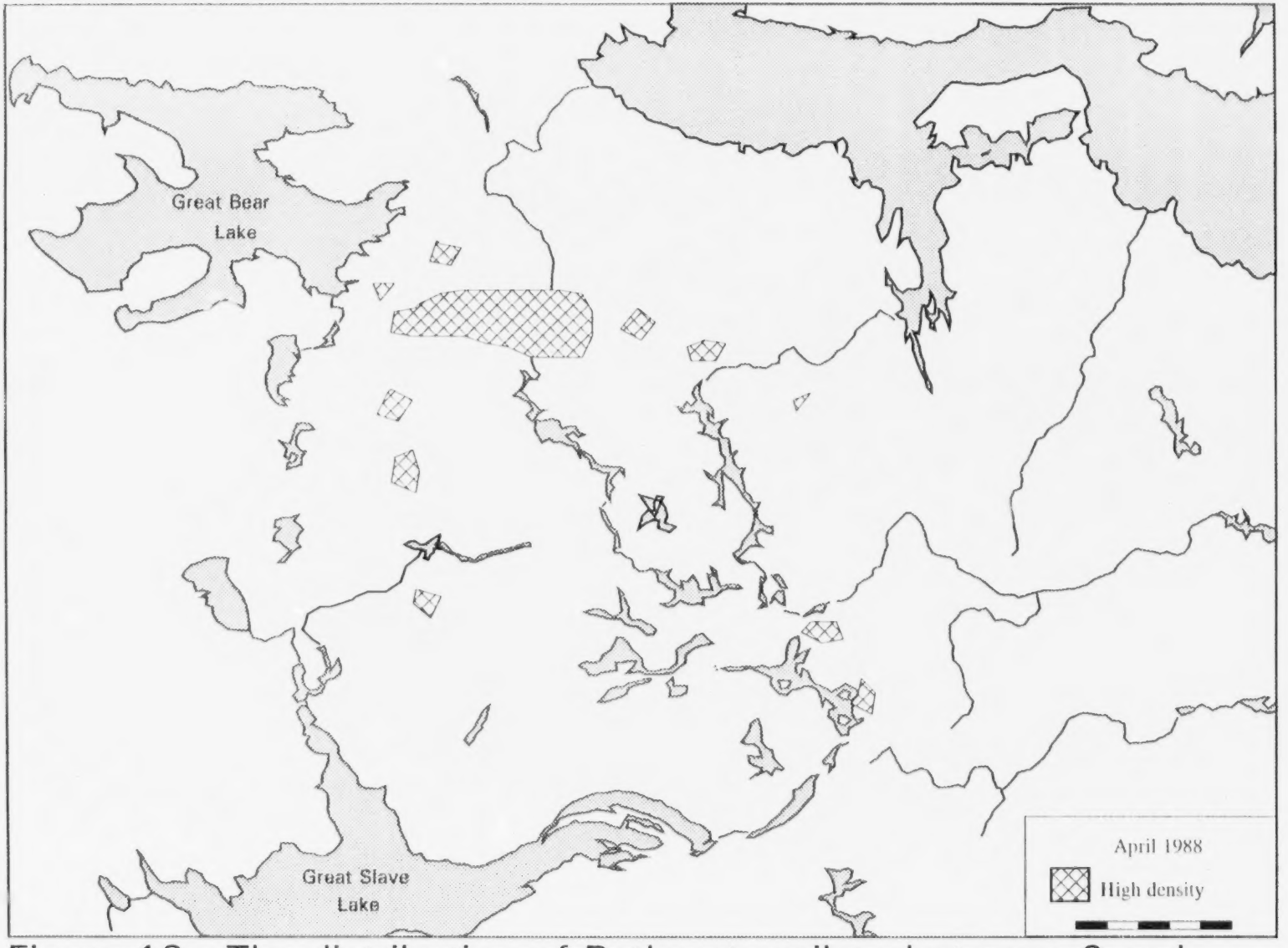

Figure 13. The distribution of Bathurst caribou between 9 and 24 April 1985.

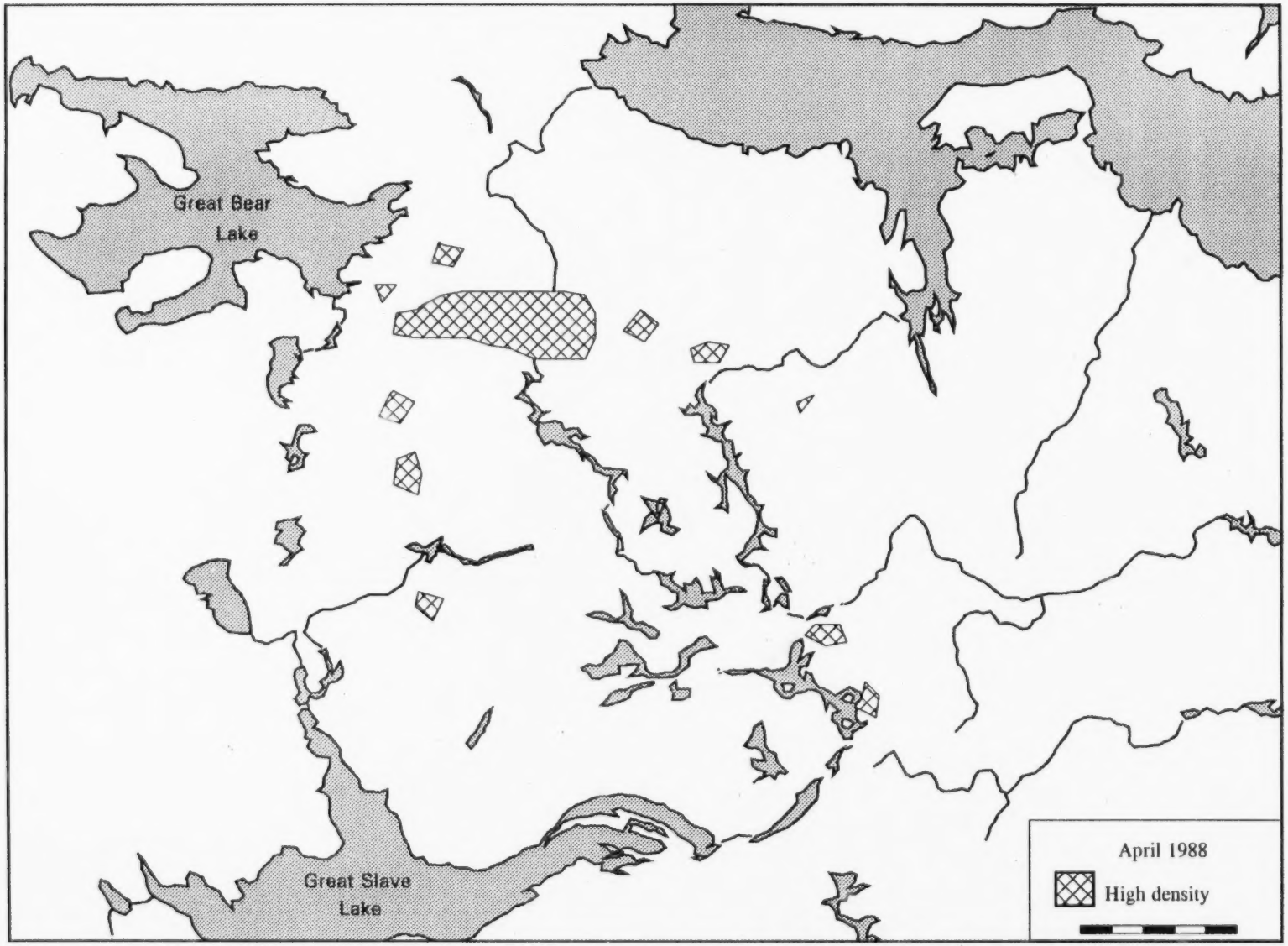

Figure 13. The distribution of Bathurst caribou between 9 and 24 April 1985.

Table 1. Summary of the Bathurst spring classification counts, 1985-1995.

Year	calves: 100 cows	SD	% calves sample	Bulls: 100 cows	% calves pop'n	% increment
1985	36	15.6	23	24	18	22
1987	37	2.4	21	40	19	23
1988	62	3.9	24	92	24	32
1989	36	2.0	21	32	18	22
1990	33	2.2	22	11	16	19
1991	46	2.9	25	40	22	28
1992	30	1.8	17	50	15	18
1993	46	1.9	23	54	22	28
1994	29	2.6	15	67	15	17
1995	47	4.1	26	32	22	28

Table 2. Summary of wolf sightings and wolf-kill sights observed on Bathurst spring classification surveys, 1985-1995.

Year	#wolves	#kills	hours flown	wolves/ 1000 hrs	wolf-kills/ 1000 hrs	mean pack size	
1985	0	2	49.5	0	40	-	
1987	29	0	30.8	942	0	3.6	
1988	5	0	24.5	204	0	2.5	
1989	11	0	23.8	462	0	5.5	
1990	29	8	31.5	921	254	3.6	
1991	45	4	21.4	2103	187	5.0	
1992	12	4	16.4	732	244	3.0	
1993	5	13	23.3	215	558	1.7	
1994	17	9	24.6	691	366	2.1	
1995	18	0	20.2	891	0	3.0	

1987 Distribution and Composition

On 23 and 24 February 1987, large numbers of caribou were found on the barrens north of Goodspeed Lake and in the trees southwest of Hottah Lake (Figure 14). Other concentrations were near Drybones and Desperation Lakes, and northwest of Gordon Lake. Small scattered groups of caribou were near Ingray and Indin Lakes and between Rolfe and Indian Hill Lakes.

From 30 groups, 6,502 caribou were classified between 7 and 13 March 1987 (Appendix C). There were 37 ± 2.4 (SD) calves for every 100 cows and female yearlings, or 21% calves in the sample. Adjusting for the observed sex ratio of 40 bulls for every 100 cows, the proportion of calves in the population was estimated at 19%, an increment of 23%.

A 23% increment is similar to the level observed in 1985 (Table 1), and indicates that calf production in June 1986 and/or overwinter survival of calves were good.

Wolf and wolf-kill sighting rates

We observed 29 wolves and 0 locations where wolves had killed caribou in 30.8 hours flown. This resulted in a sighting index of 942 wolves/1000 hrs flown (Table 2). Mean pack size was estimated at 3.6.

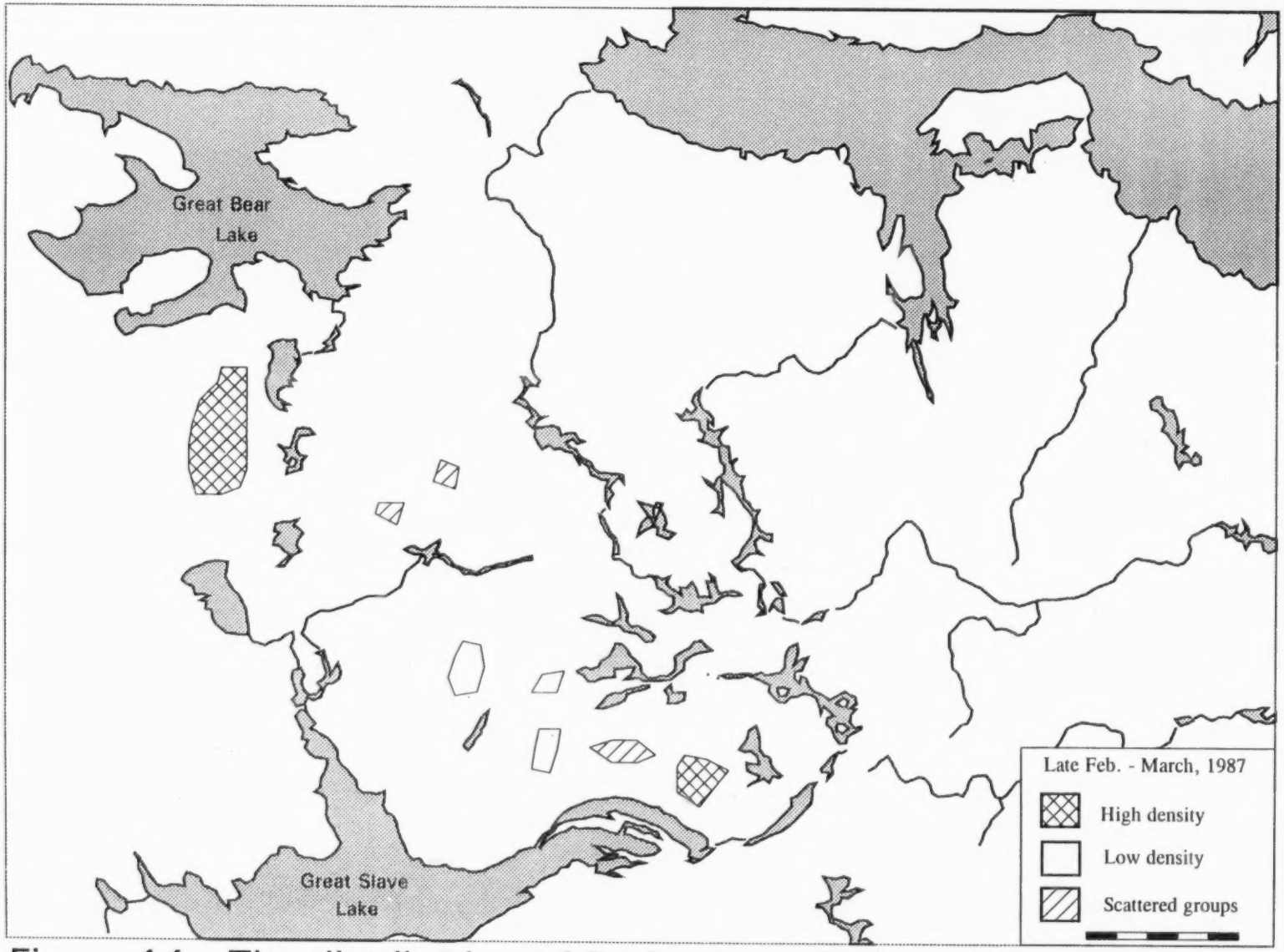

Figure 14. The distribution of Bathurst caribou between 23 February and 13 March 1987.

1988 Distribution and Composition

On 23 and 24 March 1988 caribou occupied areas located east and southeast of Faber Lake, north of Yellowknife in a band oriented northwest to Bigspruce Lake, east of the community of Rae Lakes to Ingray Lake and south to Ghost Lake, around the south end of Indin Lake, and around Snare Lake (Figure 15). Caribou were migrating northward through Snare Lake in the vicinity of Snare Village on 24 March. On 8 April it was observed that an area of approximately 400 km^2 north and northeast of Snare Village was heavily tracked. No caribou or fresh caribou sign was apparent at that time, suggesting that a large number of caribou had previously moved through the area. The latter part of that migration may have been observed on the 24 March reconnaissance flight.

From 13 groups, 3,590 caribou were classified between 8 and 17 April, 1988 (Appendix D). In 17 samples that contained cows and calves, there were 62 ± 3.9 (SD) calves for every 100 cows and female yearlings, or 24% calves in the sample. A sex ratio of 92 bulls was found for every 100 cows, which was greater than the assumed ratio of 61:100. Therefore the percent calves in the sample was not adjusted for "missing" bulls, and there were an estimated 24% calves in the populations, an increment of 32%.

A 32% increment is the highest recorded since 1984 (Table 1), and indicates that calf production in June 1987 and over-winter calf survival were very good.

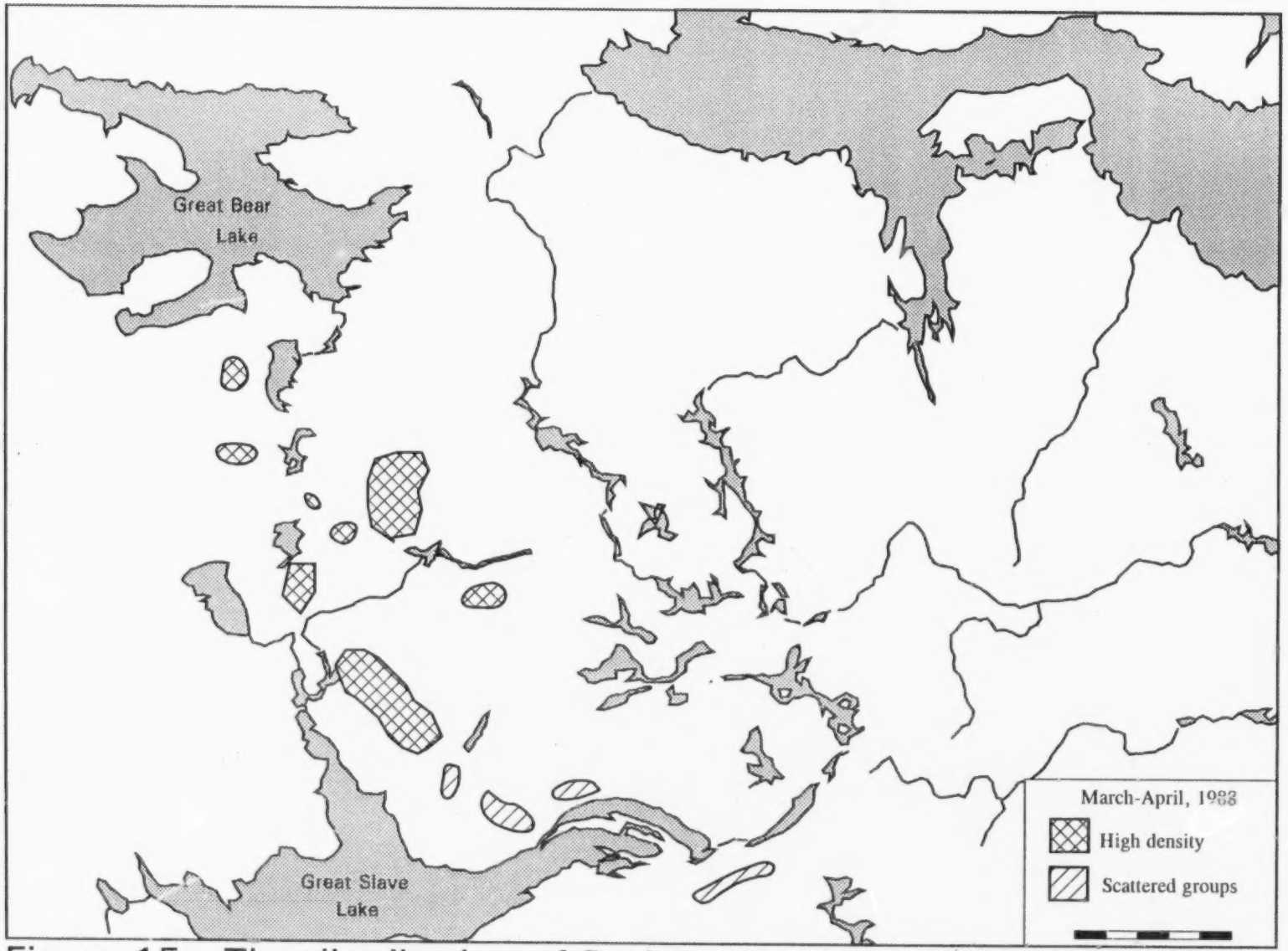

Figure 15. The distribution of Bathurst caribou between 22 March and 17 April 1988.

Wolf and wolf-kill sighting rates

We observed 5 wolves and 0 locations where wolves had killed caribou in 24.5 hours flown, resulting in a sighting index of 204 wolves/1000 hrs flown (Table 2). Mean pack size was estimated at 2.5.

1989 Distribution and Composition

Between 15 and 30 March, 1989, most of the caribou located occupied a band that ran west from Greenstockings Lake to Indin Lake, and north from Wecho Lake to Big Lake. A herd of approximately 5,000 caribou, located about 8 km north of Drybone Lake, were migrating to the northeast. Caribou were also migrating across Snare Lake near Snare Village. The caribou near Indin Lake were migrating northwards onto the barrens in the vicinity of Spider and Truce Lakes. Small, scattered groups of caribou were found near Ghost Lake, Victory Lake, and Inglis Lake (Figure 16).

We classified 2268 caribou from 17 groups between 20 and 30 of March 1989 (Appendix E). In 17 samples that contained cows and calves, there were 36$\pm$ 2.0 (SD) calves for every 100 cows and female yearlings, or 21% calves in the sample. Adjusting for the observed sex ratio of 32 bulls for every 100 cows, the proportion of calves in the population was estimated at 18%, resulting in an increment of 22%.

A 22% increment rate is similar to what was found in 1987 and 1985 (Table 1), and indicates that both calf production in 1988 and over-winter survival were very good.

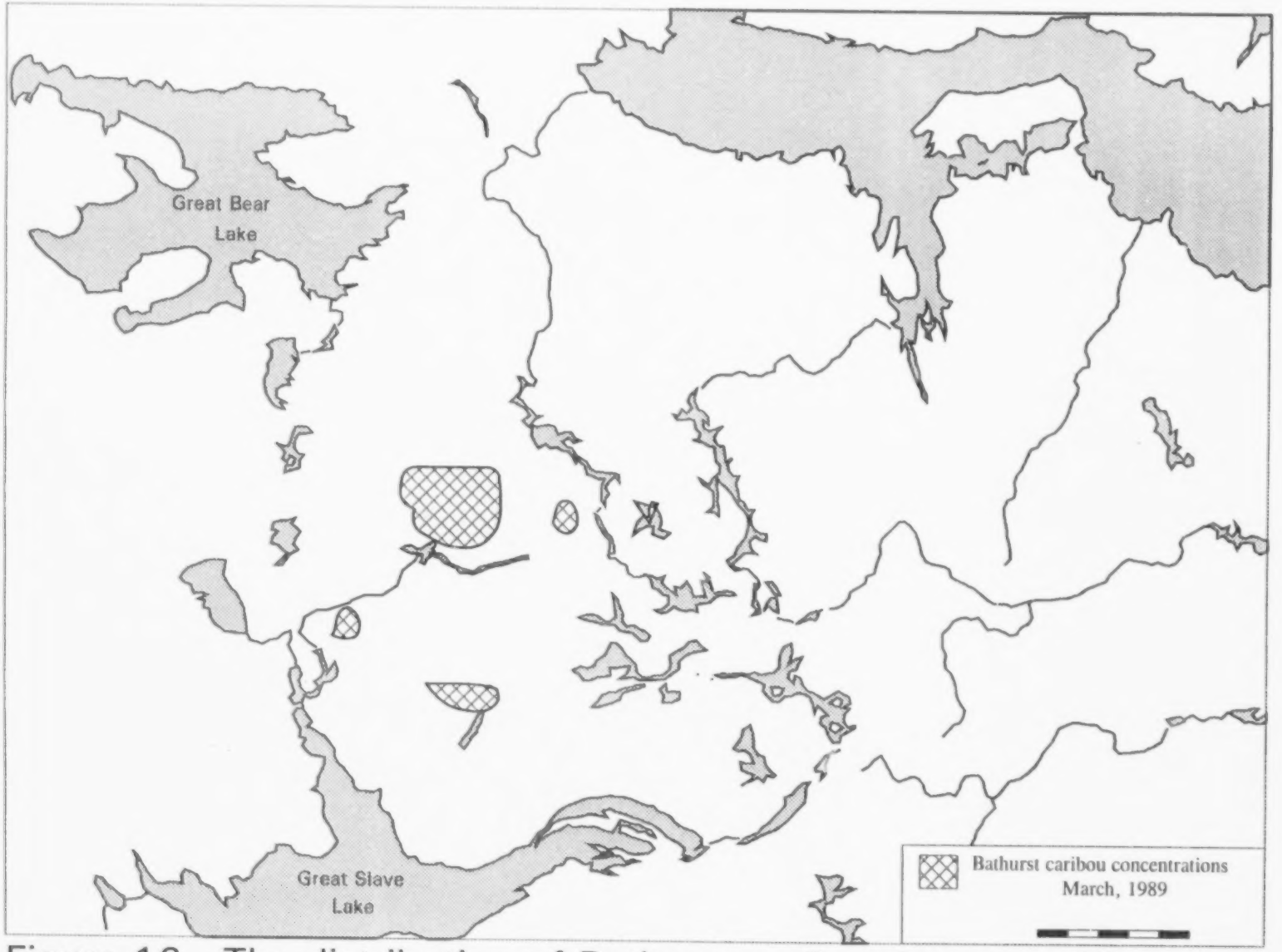

Figure 16. The distribution of Bathurst caribou between 15 and 30 March 1989.

Wolf and wolf-kill sighting rates

We observed 11 wolves and 0 locations where wolves had killed caribou in 23.8 hours flown, resulting in a sighting index of 462 wolves/1000 hrs flown (Table 2). Mean pack size was estimated at 5.5.

1990 Distribution and Composition

Surveys flown during late February and mid-March, 1990, revealed a high density band of caribou running east from Ghost Lake to Reindeer Lake, south of Snare River. Large numbers of caribou were also located around Indin Lake and between Fenton Lake and the Beaulieu River. Scattered groups were found east of Jennejonn Lake to Taltheilei Narrows in Great Slave Lake (Figure 17).

From 15 groups, 3558 caribou were classified between 13 and 18 March, 1990 (Appendix F). This yielded a rate of 33 $\pm$ 2.2 (SD) calves/100 cows and a 22% proportion of calves in the sample. Adjusting for an observed sex ratio of 11 bulls for every 100 cows, the estimated proportion of calves in the population was 16% which is a 19% increment(Table 1). This increment rate is similar to the three years previous, indicating that both over-winter survival and 1989 calf production were good.

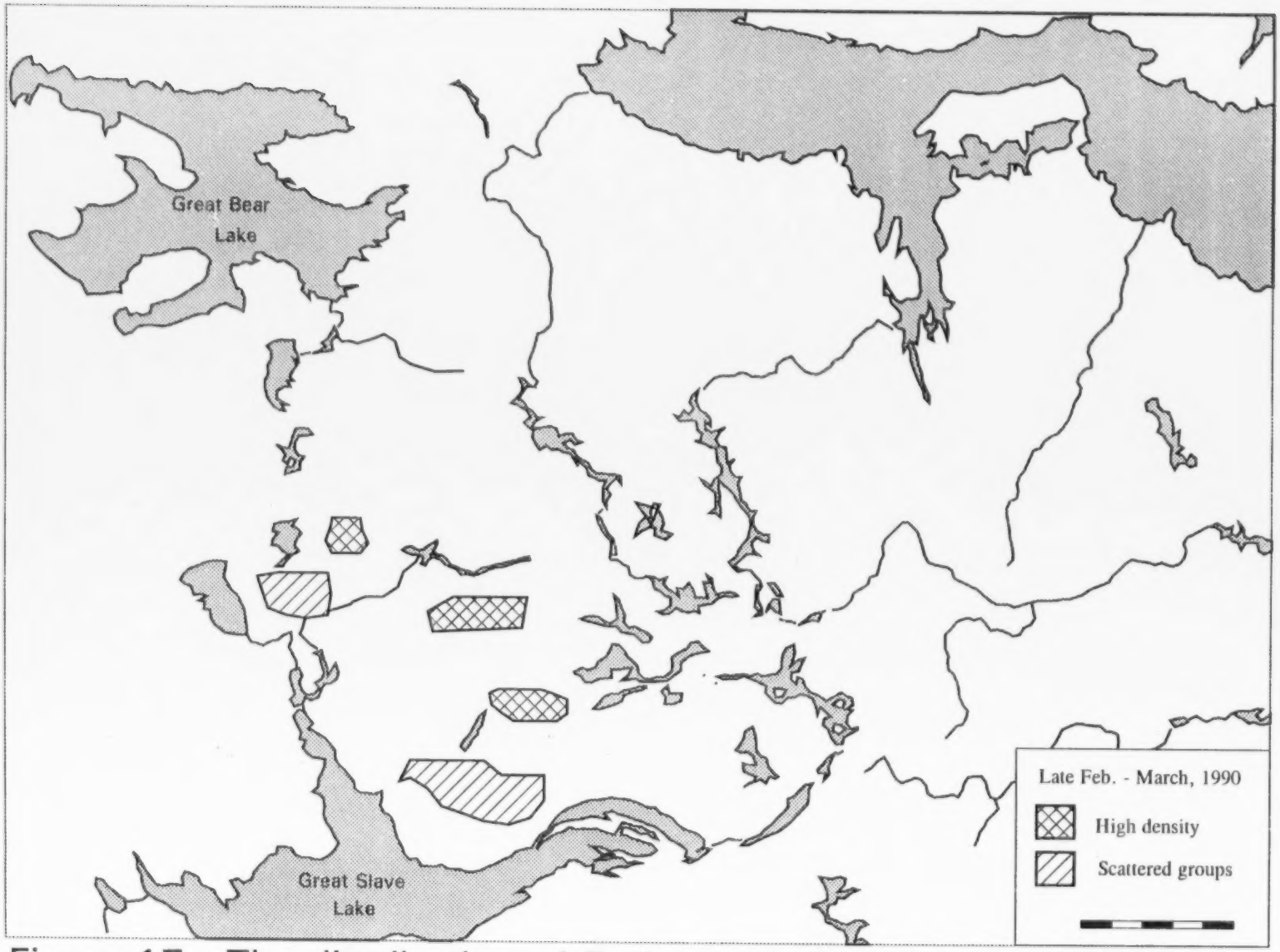

Figure 17. The distribution of Bathurst caribou between 27 February and 18 March 1990.

Wolf and wolf-kill sighting rates

Twenty nine wolves and eight locations where wolves had killed caribou were observed in 31.5 hours flown. The estimated sighting indices were 921 wolves/1000 hrs and 254 kills/1,000 hrs flown with a mean pack size estimated at 3.6 (Table 2).

1991 Distribution and Composition

High density pockets of caribou were observed between Upper Carp Lake and the Wecho River, and between Castor and Rodrigues Lakes. Caribou also occupied a high density band that was oriented northwest-southeast from Upper Carp and Reindeer Lakes to Indin Lake. Small scattered groups of caribou were located between the south end of Gordon Lake and Bliss Lake and throughout the area east of Jennejohn Lake to Simpson Islands in Great Slave Lake (Figure 18).

From 45 groups, 5,492 caribou were classified between 6 and 8 March 1991 (Appendix G). In 45 groups that contained cows and calves, there were 45.7 ± 2.86 (SD) calves for every 100 cows and female yearlings, or 24.7% calves in the sample. Adjusting for the observed sex ratio of 40 bulls for every 100 cows, the proportion of calves in the population was estimated at 21.6%, which is an increment of 28%.

A 28% increment is greater than that found in all years from 1985-1990 but for an exceptionally high increment in 1988 (Table 1), and indicated that both calf production in 1990 and over-winter survival were very good.

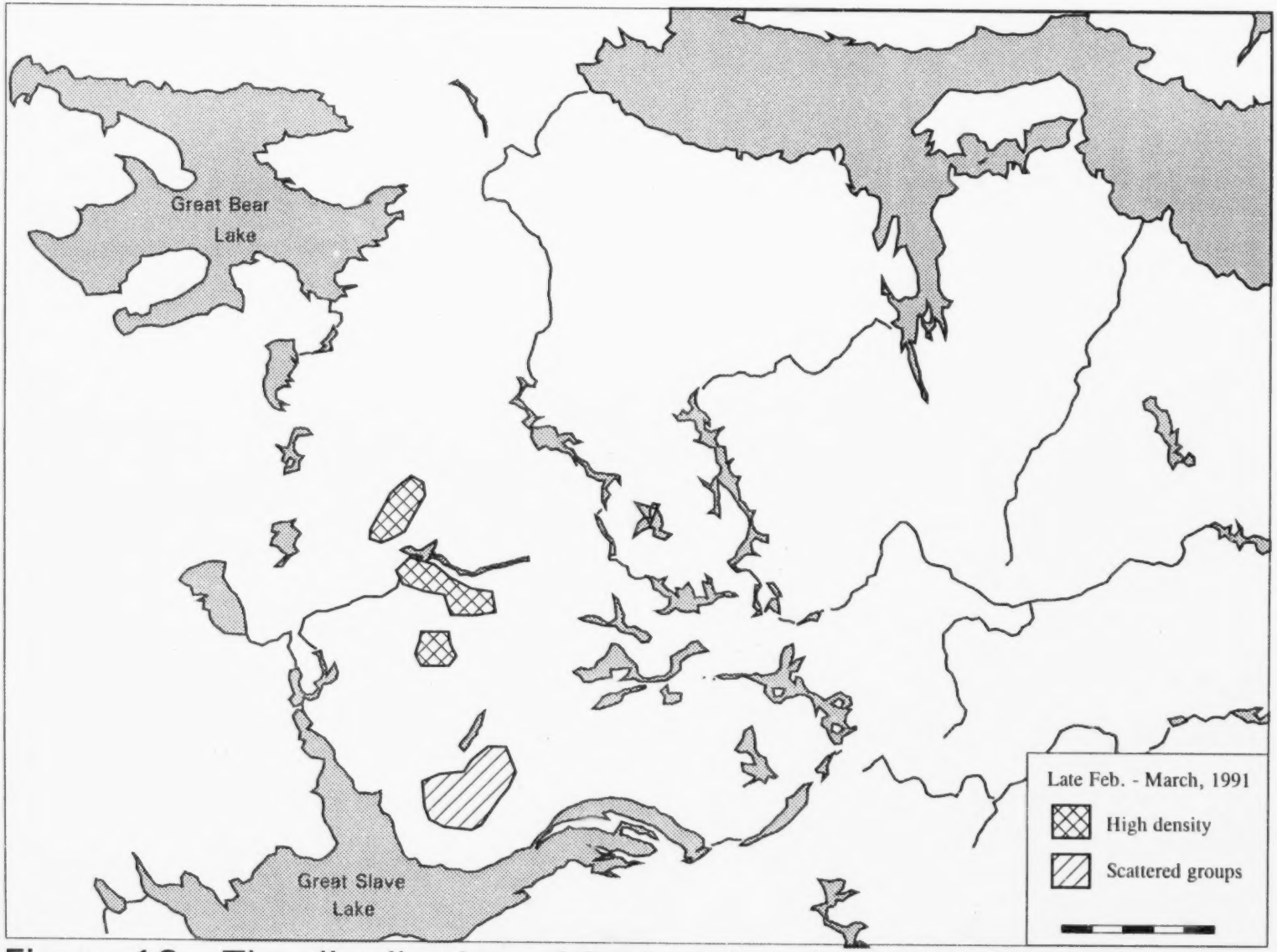

Figure 18. The distribution of Bathurst caribou between 28 February and 8 March 1991.

Wolf and wolf-kill sighting rates

We observed 45 wolves and 4 locations where wolves had killed caribou in 21.4 hours of flying, for sighting indices of 2,103 wolves/1000 hrs and 187 kills/1,000 hours (Table 2). Mean pack size was estimated at 5.0.

1992 Distribution and Composition

Between 13 and 19 March 1992 a high density pocket of caribou was observed between Armi and Snare Lakes, west of Wecho Lake. There were small scattered groups of caribou along the Beaulieu River from Francois Lake in the south to Sunset Lake in the north (Figure 19).

Classifications were made of 4121 caribou from 36 groups on 18 and 19 March 1992 (Appendix H). There were 29.8 $\pm$ 1.76 (SD) calves for every 100 cows and female yearlings, or 16.6% calves in the sample. Adjusting for the observed sex ratio of 50 bulls for every 100 cows, the proportion of calves in the population was estimated at 15.2%, which is an increment of 18%.

An 18% increment rate is similar to that found in previous surveys except for exceptionally high increments in 1988 and 1991 (Table 1), and indicates that calf production in 1991 and/or over-winter survival were slightly below average.

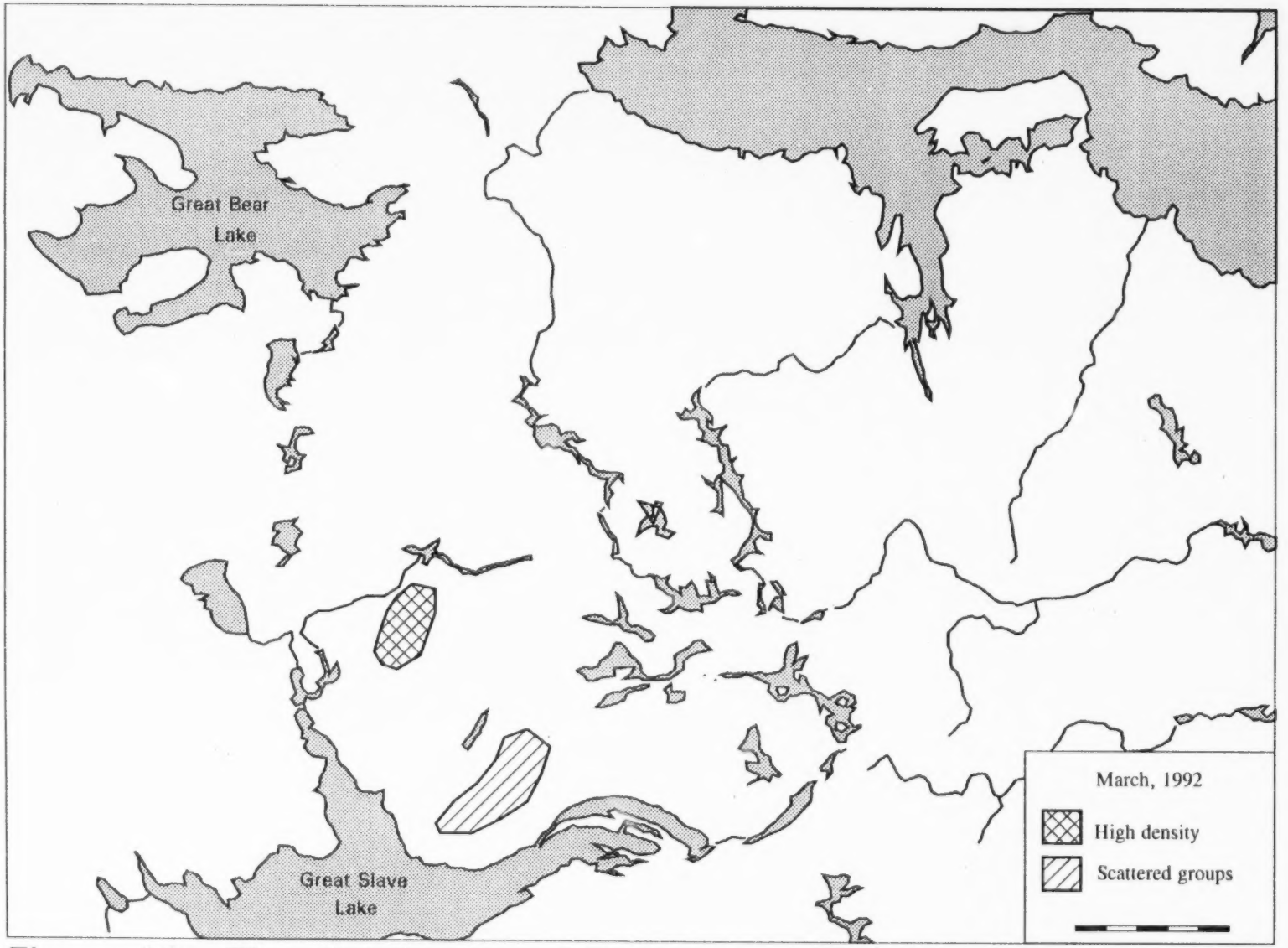

Figure 19. The distribution of Bathurst caribou between 13 and 19 March 1992.

Wolf and wolf-kill sighting rates

Twelve wolves and four locations where wolves had killed caribou were observed in 16.4 hours of flying, for sighting indices of 732 wolves/1000 hrs and 244 kills/1000 hours (Table 2). Mean pack size was estimated at 3.0

1993 Distribution and Composition

Between 12 February and 11 March 1993 high density pockets of caribou were observed around Bigspruce and Kwejinne Lakes, around the north end of Wheeler Lake east to the Yellowknife River, between Ross and Desperation Lakes, and from the Beaulieu River south of Watta Lake to the north shore of Great Slave Lake east of McKinley Point (Figure 20).

Classifications were made of 5417 caribou from 44 groups on 15 and 16 March, 1993 (Appendix I). In 42 samples that contained cows and calves, there were 46 $\pm$ 1.9 (SD) calves for every 100 cows and female yearlings, or 23% calves in the sample. Adjusting for the observed sex ratio of 54 bulls for every 100 cows, the proportion of calves in the population was estimated at 22% , which is an increment of 28%.

A 28% increment rate is similar to high increments found in 1988 and 1991 (Table 1), and indicates that calf production in June 1992 and/or over-winter survival were exceptionally good.

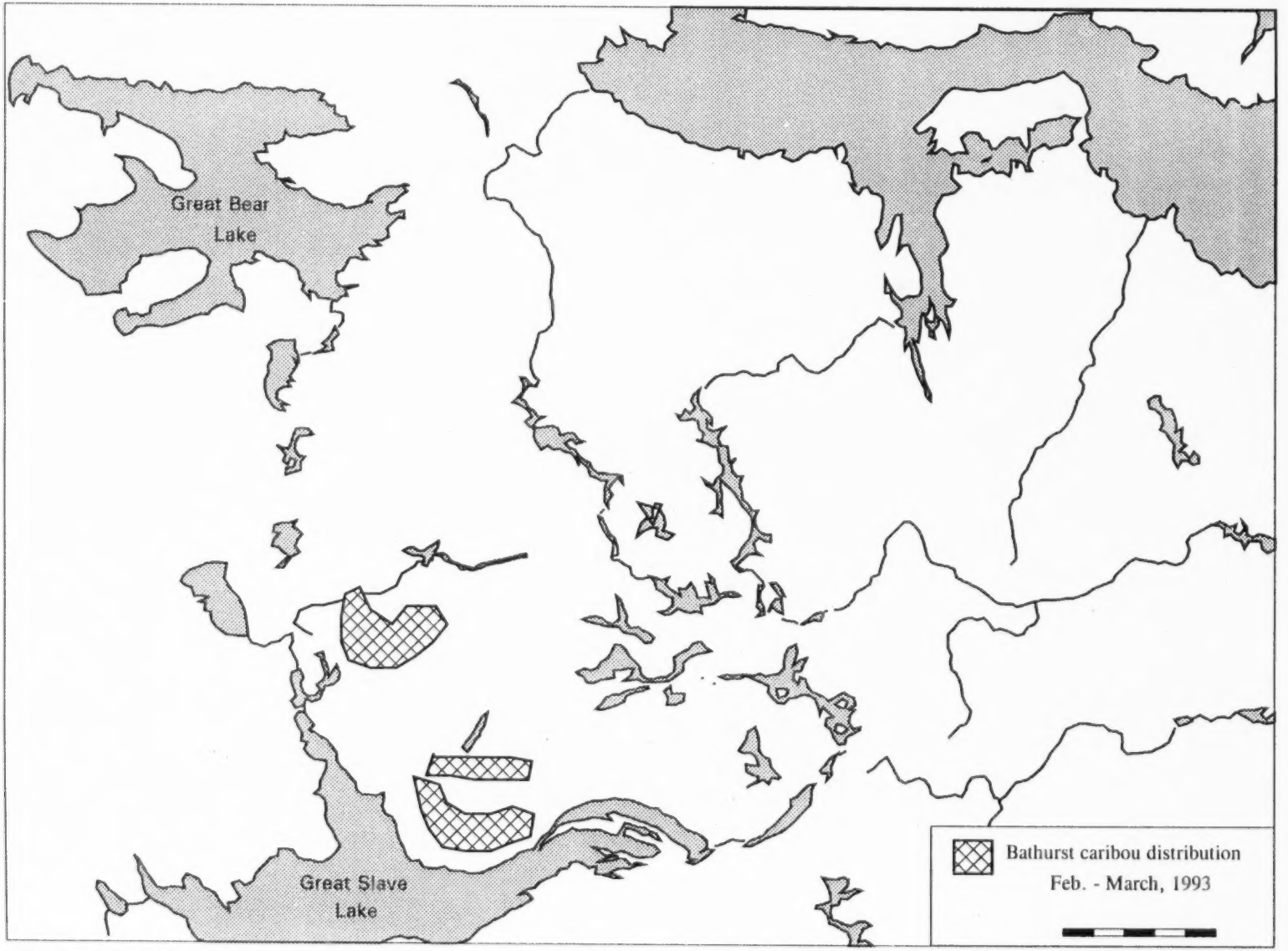

Figure 20. The distribution of Bathurst caribou between 12 February and 16 March 1993.

Wolf and wolf-kill sighting rates

Five wolves and 13 locations where wolves had killed caribou were observed in 23.3 hours of flying, giving sighting indices of 215 wolves/1000 hours and 558 kills/1000 hours (Table 2). Mean pack size was 1.7 ± 1.15 (SD).

1994 Distribution and Composition

Reconnaissance flights from 7-10 March confirmed reports that large numbers of caribou wintered west of the community of Rae Lakes and north of Lac la Martre. Caribou were also found east from Hottah Lake to Bishop Lake, east of Ghost Lake, northeast of Germaine Lake, between Sharples and Drybones Lakes, west of Gordon Lake and around Thistlethwaite Lake (Figure 21). By 21 March caribou had migrated northeast from Germaine and north from Thistlethwaite Lakes and were moving in large numbers northeast across Phoenix, Thetis and Squalus Lakes towards Sharples Lake.

From 40 groups, 4,420 caribou were classified on 21 and 22 of March, 1994 (Appendix J). In 40 samples that contained cows and calves, there were 29 ± 2.6 (SD) calves for every 100 cows and female yearlings, or 15% calves in the sample. A sex ratio of 67 bulls was found for every 100 cows, indicating that the sample did not under- represent the bull component of the Bathurst herd. Therefore the proportion of calves in the population was not adjusted, and represented an increment of 17%.

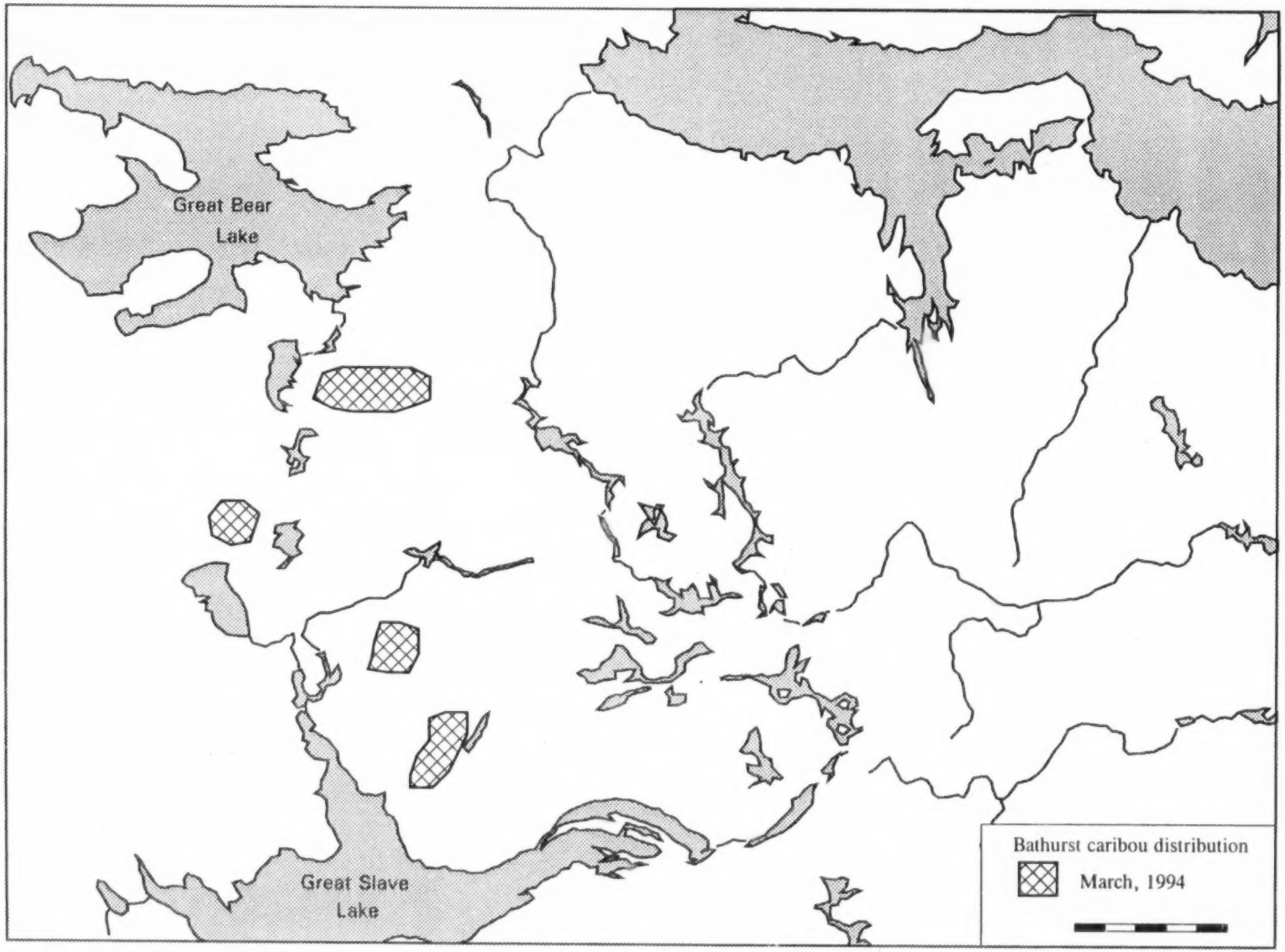

Figure 21. The distribution of Bathurst caribou between 7 and 22 March 1994.

A 17% increment rate is similar to increments observed in 1990 and 1992 and indicates that calf production in June 1993 and/or calf survival to March 1994 was below average, as determined for 8 previous spring classification surveys of the Bathurst herd from 1985 to 1993 (Table 1).

Wolf and wolf-kill sighting rates

Observations were made of 17 wolves and 9 locations where wolves had killed caribou in 24.6 hours of flying, giving sighting indices of 691 wolves/1000 hrs and 366 kills/1000 hours (Table 2). Mean pack size was 2.1 ± 1.36 (SD).

1995 Distribution and Composition

Reconnaissance flights on 27 and 28 February confirmed reports that some caribou wintered southwest of Lac la Martre. However, the greatest number of caribou located were between Lac la Martre and Great Bear Lake in an area bordered by Lac Ste Therese to the west, Lac Grandin to the south, and Hottah Lake to the east (Figure 22). Caribou were also found north of Prelude Lake in a band running northeast across the south end of Gordon Lake to the Beaulieu River. There was no sign of any concerted caribou movements out of the boreal forest at that time.

Classifications of 3,190 caribou were made from 39 groups on 6 and 7 of March, 1995 (Appendix K). In 37 samples that contained cows and calves, there were 47 ± 4.1 (SD) calves for every 100 cows and female yearlings, or 26% calves in the sample.

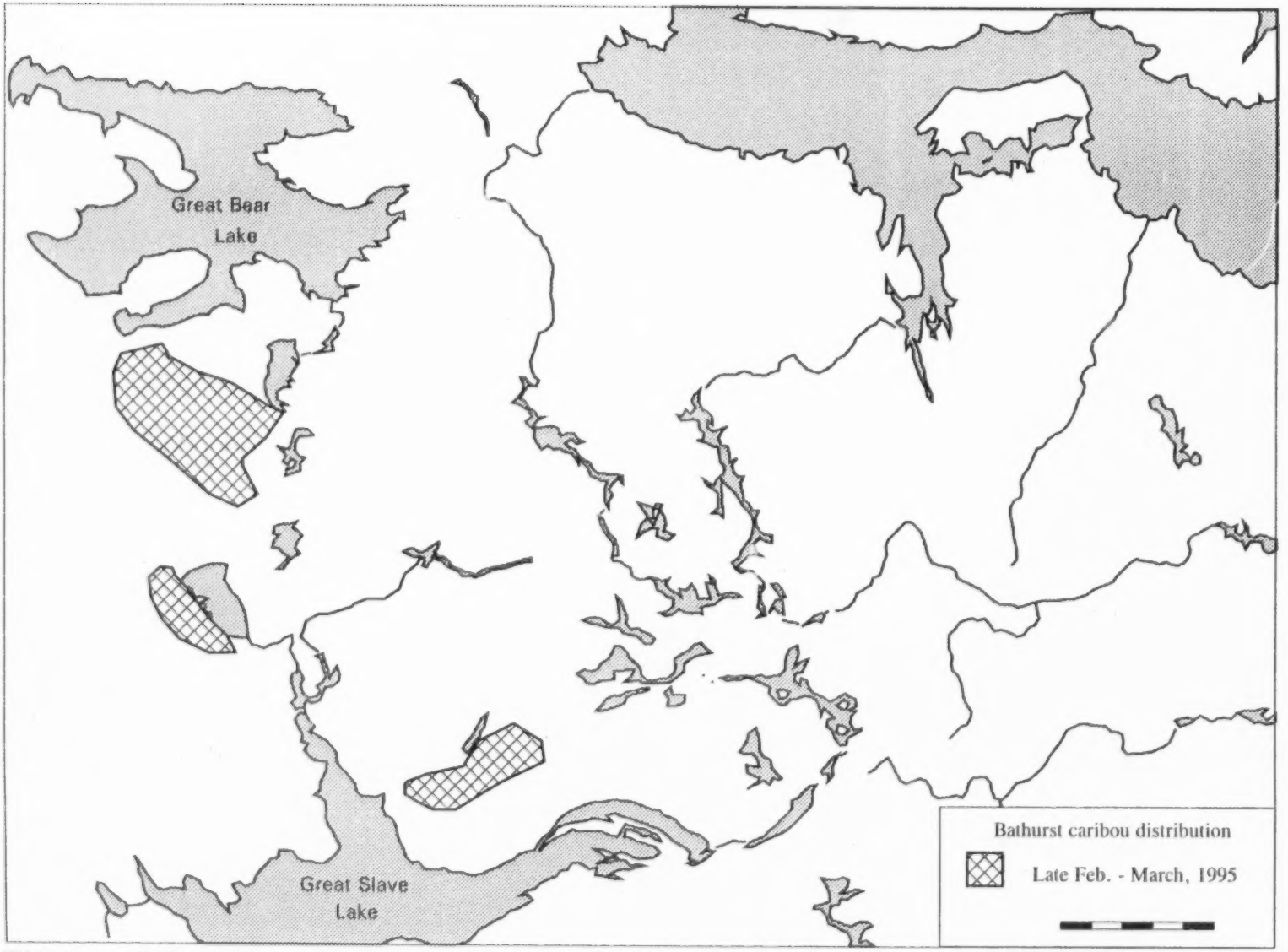

Figure 22. The distribution of Bathurst caribou between 27 February and March 1995.

Adjusting for the observed sex ratio of 32 bulls for every 100 cows, the proportion of calves in the population was estimated at 22%, resulting in an increment of 28%.

A 28% increment rate is similar to increments recorded in 1988, 1991 and 1993 and indicates that calf production in June 1994 and/or calf survival to March 1995 was above average, as determined for nine previous spring classification surveys of the Bathurst herd from 1985 to 1994 (Table 1).

Wolf and wolf-kill sighting rates

Eighteen wolves were observed but there were no sightings of wolf kill locations in 20.2 hours of flying, giving sighting indices of 891 wolves/1000 hrs and 0 kills/1000 hours (Table 2). Mean pack size was 3.0 ± 1.67 (SD).

LITERATURE CITED

Caughley, G. 1974. Interpretation of age ratios. Journal of Wildlife Management. 38:557-562.

Cochran, W.C. 1977, Sampling techniques. 3rd Edition. J. Wiley and Sons Ltd., New York. 413 pp.

Gunn, A. 1984. Sex and age composition of the Beverly herd of barren-ground caribou in the fall of 1981 and 1982. N.W.T. Renewable Resources File Report No. 40.

Krebs, C.J., B.S. Gilbert, S. Boutin, A.R.E. Sinclair, and J.N.M. Smith. 1986. Population biology of Snowshoe Hares. I. Demography of food-supplemented populations in the southern Yukon, 1976-84. Journal of Animal Ecology 55:963-982.

McCullough, D.R. 1994. What do herd composition counts tell us? Wildl. Soc. Bull. 22:295-300.

Appendix A. Sample calculations and formulas

Estimation of variance (Cochran 1977: 155, 6.13):

$$v_2(R)=\frac{(1-f)}{nx^2}(s_y^2+R^2s_x^2-2Rs_{yx})$$

Sample Calculations:

1. Sex ratio of animals over 1 year olds (+1) in sample:

   cows= 3197, female yearlings= 460, male yearlings= 326, bulls= 1155, calves= 1363

   1155 + 326 = 1481 +1 males
   3197 + 460 = 3657 +1 females

   (1481 +1 males/3657+1 females) x 100 = 40 +1 males: 100 +1 females

2. Calves: 100 +1 cow ratio:

   (1363 calves/3657 +1 females) X 100 = 37 calves: 100 +1 cows

3. Percent calves in sample:

   Total animals (sample)= 3197 + 460 + 326 + 1155 + 1363 = 6501

   1363 calves/ 6501(sample total) X 100 = 21% calves

4. Percent calves in population:

   Adjust total +1 males (using assumed population ratio of 61 males: 100 females)
   61 x 3657 females/100 = 2230 +1 males

   2230 - 1481 = 749 (unobserved male population segment, using above assumed sex ratio))

   Percent calves = (1363 calves/(6501 + 749)) X 100 = 19% calves

5. Percent recruitment (increment) :

   19% calves/ 81% +1 animals = 23% increment

Appendix B. Summary of Bathurst spring classification counts, 17-20 April, 1985.

		Calves*		Yearlings		Bulls		
Group	Cows	♂	♀	♂	♀	Young	Mature	Total
17 April								
1	150	23	23	9	4	26	18	253
2	195	13	14	5	4	7	2	240
20 April								
3	578	138	137	16	28	108	41	1046
Total	923	174	174	30	36	141	61	1539

* Calves were not sexed, therefore counts were divided evenly between sex classes.

Appendix C. Summary of Bathurst spring classification counts, 7-13 March, 1987.

		Calves		Yearlings		Bulls		
Group	Cows	♂	♀	♂	♀	Young	Mature	Total
March 7								
1	130	21	22	11	7	37	2	230
2	146	17	16	13	10	13	1	216
3	111	11	16	8	12	17	10	185
4	96	8	11	5	14	28	1	163
March 8								
5	418	69	88	36	51	108	8	778
6	97	21	17	7	16	6	2	166
7	140	38	36	25	40	62	2	343
8	105	20	23	11	9	27	1	196
March 9								
9	169	21	40	15	25	43	1	314
10	283	21	58	10	34	61	6	474
11	275	68	63	13	29	52	15	515
12	162	15	18	6	16	43	4	264
March 10								
13	105	13	23	7	6	66	10	230
14	14	17	4	9	1	31	2	78
15	49	17	14	7	9	35	2	133
16	38	17	16	4	4	19	6	104
March 11								
17	12	8	5	4	1	13	18	61
18	30	1	8	3	7	1	2	52
19	75	22	13	12	15	23	8	168
20	40	9	14	8	5	25	4	105
21	25	7	8	3	2	15	63	123
22	60	15	16	12	17	12	1	133
23	71	23	18	9	9	30	6	166
24	65	22	9	18	18	33	1	166
March 12								
25	47	15	14	31	7	18	2	106
26	48	18	19	10	18	25	0	138
27	28	9	12	9	10	17	0	85
March 13								
28	183	45	43	15	32	38	2	358
29	105	29	21	12	21	18	0	206
30	70	42	38	21	16	55	4	246
Total	3197	682	681	326	461	971	184	6502

Appendix D. Summary of Bathurst spring classification counts, 8-17 April, 1988.

		Calves		Yearlings		Bulls		
Group	Cows	♂	♀	♂	♀	Young	Mature	Total
April 8								
1	18	72	12	4	6	18	6	71
2	61	14	25	4	4	14	4	126
3	279	80	115	39	45	154	22	734
4	1	0	0	0	0	23	101	125
April 9								
5	13	12	7	8	2	37	0	79
6	70	54	38	35	8	84	23	312
7	28	13	14	10	3	16	0	84
8	36	23	21	13	3	29	7	132
April 14								
9	102	35	42	21	24	96	8	328
10	108	64	54	16	14	91	6	353
11	84	32	48	9	10	30	6	219
April 16								
12	375	70	74	38	75	110	28	770
April 17								
13	45	9	6	6	2	35	154	257
Total	1220	413	456	203	196	737	365	3590

Appendix E. Summary of Bathurst spring classification counts, 20-30 March, 1989.

		Calves*		Yearlings		Bulls**		
Group	Cows	♂	♀	♂	♀	Young	Mature	Total
March 20								
1	25	5	5	1	1	16	0	53
2	52	10	7	11	6	7	0	93
3	99	18	10	7	11	7	0	152
4	263	54	44	18	24	23	0	426
March 21								
5	82	20	18	9	7	39	0	175
6	126	25	20	2	6	26	0	205
7	72	12	21	11	10	36	0	162
March 22								
8	40	5	1	4	3	13	0	66
9	18	10	3	3	0	8	0	42
10	51	12	13	2	3	11	0	92
11	36	4	6	1	2	3	0	52
12	105	27	21	6	8	28	0	195
March 23								
13	75	15	16	1	4	32	0	143
14	21	9	4	2	0	30	0	66
15	128	18	22	5	5	21	0	199
16	0	0	0	0	0	20	0	20
March 30								
17	63	24	10	1	6	23	0	127
Total	1256	268	221	84	96	343	0	2268

*Calves not classified to sex were divided evenly between the sex classes.
**Bulls were not differentiated to maturity, therefore all bulls were placed in the young bull class.

Appendix F. Summary of Bathurst spring classification counts, 13-18 March, 1990.

		Calves*		Yearlings		Bulls**		
Group	Cows	♂	♀	♂	♀	Young	Mature	Total
March 13								
1	50	14	11	1	4	7	0	87
2	188	50	44	12	22	34	0	350
3	242	34	31	11	8	26	0	352
4	275	37	50	19	32	18	0	431
March 14								
5	188	27	33	5	25	32	0	310
6	198	32	45	11	34	23	0	343
March 16								
7	125	27	17	3	10	15	0	197
8	117	23	30	8	19	12	0	209
9	143	18	22	6	27	21	0	237
March 17								
10	54	18	10	3	6	11	0	102
11	92	28	25	8	20	11	0	184
12	255	45	37	11	36	24	0	408
March 18								
13	152	34	36	20	20	27	0	289
14	22	9	7	3	3	2	0	46
15	7	1	2	0	3	0	0	13
Total	2108	397	400	121	269	263	0	3558

*Calves not classified to sex were divided evenly among the sex classes.
**Bulls were not differentiated to maturity, therefore all bulls were placed in the young bull class.

Appendix G. Summary of Bathurst spring classification counts, 6-8 March, 1991.

		Calves*		Yearlings		Bulls**		
Group	Cows	♂	♀	♂	♀	Young	Mature	Total
March 6								
1	24	6	5	4	0	6	0	45
2	23	4	4	2	2	15	0	50
3	15	3	1	1	2	4	0	26
4	37	14	12	4	2	21	0	90
5	63	11	15	3	1	15	0	108
6	47	15	8	2	6	17	0	95
7	66	19	20	4	6	27	0	142
8	68	21	23	3	2	17	0	134
9	123	44	35	9	8	50	0	269
10	33	12	4	4	1	9	0	63
11	27	10	4	2	0	12	0	55
12	101	21	14	10	6	38	0	190
13	81	15	19	5	2	16	0	138
14	42	9	13	4	0	16	0	84
15	83	14	19	3	4	32	0	155
16	88	28	20	2	5	31	0	174
17	87	13	18	4	5	36	0	163
18	39	1	4	0	1	3	0	48
19	21	1	6	1	2	13	0	44
20	148	20	46	5	6	27	0	252
21	246	29	37	11	6	53	0	382
22	68	21	22	5	4	32	0	152
March 7								
23	26	10	10	4	3	24	0	77
24	52	12	16	1	9	17	0	107
25	38	11	11	0	5	6	0	71
26	80	18	22	6	8	22	0	156
27	79	18	22	6	9	37	0	171
28	55	13	23	8	7	49	0	155
29	185	39	56	7	15	34	0	336
30	97	13	25	6	6	44	0	191
31	62	9	4	1	2	2	0	80
32	117	14	18	7	7	16	0	179
33	36	3	7	5	1	11	0	63
34	68	12	15	0	1	10	0	106
35	58	17	11	6	2	18	0	112
36	24	10	7	3	0	20	0	64
37	6	3	3	0	1	0	0	13
38	6	2	4	1	0	9	0	22
39	3	5	2	4	0	3	0	17
40	21	9	15	2	2	19	0	68
41	13	15	12	5	1	29	0	7
42	35	4	8	0	3	6	0	56
43	95	34	34	18	10	66	0	257
March 8								
44	77	46	14	8	7	50	0	202
45	22	8	12	2	4	7	0	55
Total	2785	656	700	188	174	989	0	5492

*Calves not classified to sex were divided evenly among the sex classes.
**Bulls were not differentiated to maturity, therefore all bulls were placed in the young bull class.

Appendix H. Summary of Bathurst spring classification counts, 18-19 March, 1992.

		Calves		Yearlings		Bulls*		
Group	Cows	♂	♀	♂	♀	Young	Mature	Total
March 18								
1	142	20	18	8	6	20	0	214
2	139	16	27	4	11	28	0	225
3	177	15	21	9	8	32	0	262
4	84	15	13	5	0	38	0	155
5	68	9	11	6	2	37	0	133
6	64	11	7	8	4	46	0	140
7	62	8	10	1	2	14	0	97
8	54	7	9	1	0	33	0	104
9	68	8	12	1	4	45	0	138
10	19	4	2	2	6	14	0	47
11	146	37	27	4	5	41	0	260
12	80	8	23	2	1	30	0	144
13	64	11	16	6	1	22	0	120
14	119	9	18	5	5	44	0	200
15	140	20	27	13	9	55	0	264
16	201	39	27	11	7	74	0	359
17	101	10	6	4	2	12	0	135
18	73	7	8	1	5	26	0	120
March 19								
19	0	0	0	0	0	19	0	19
20	0	0	0	0	0	18	0	18
21	8	1	5	1	1	17	0	33
22	6	4	2	0	1	56	0	69
23	0	0	0	0	0	70	0	70
24	10	3	3	2	2	4	0	24
25	75	17	13	2	3	20	0	130
26	103	9	15	7	4	12	0	150
27	29	4	6	3	3	11	0	56
28	23	4	4	0	0	9	0	40
29	45	9	11	5	5	10	0	85
30	27	5	9	2	3	4	0	50
31	55	8	10	4	4	13	0	94
32	6	0	5	3	0	19	0	33
33	0	1	0	0	0	20	0	21
34	0	0	0	0	0	11	0	11
35	0	0	0	0	0	77	0	77
36	0	0	0	0	0	24	0	24
Total	2188	319	365	120	104	1025	0	4121

*Bulls were not differentiated to maturity, therefore all bulls were placed in the young bull class.

Appendix I. Summary of Bathurst spring classification counts, 15-16 March, 1993.

		Calves		Yearlings		Bulls*		
Group	Cows	♂	♀	♂	♀	Young	Mature	Total
March 15								
1	7	2	4	3	1	18	0	35
2	7	7	2	1	2	37	0	56
3	30	12	12	10	1	29	0	94
4	42	15	12	5	4	33	0	111
5	66	18	21	5	3	22	0	135
6	43	12	7	4	1	12	0	79
7	46	13	9	3	5	7	0	83
8	67	9	13	5	2	18	0	114
9	65	8	10	0	4	29	0	116
10	48	8	13	1	0	18	0	88
11	73	8	16	2	2	29	0	130
12	68	14	17	8	5	27	0	139
13	47	3	3	0	0	6	0	59
14	30	3	5	0	0	14	0	52
15	64	18	14	7	2	48	0	163
16	49	10	14	1	5	17	0	96
17	39	12	10	5	2	22	0	90
18	4	1	0	0	0	52	0	57
19	48	9	6	2	0	19	0	84
20	168	36	33	24	4	94	0	359
21	6	1	3	0	1	1	0	12
22	54	12	12	4	3	13	0	98
23	27	7	5	1	3	12	0	55
24	40	7	6	2	0	8	0	63
25	90	13	21	8	6	22	0	160
March 16								
26	42	12	19	9	6	22	0	100
27	74	32	20	10	7	29	0	172
28	30	6	8	5	4	24	0	77
29	78	22	21	7	4	65	0	197
30	35	9	7	6	3	13	0	73
31	49	11	13	5	3	24	0	105
32	38	9	13	3	3	11	0	77
33	44	11	13	5	3	13	0	89
34	75	21	34	6	2	34	0	172
35	48	17	17	3	5	41	0	131
36	181	55	52	18	14	80	0	400
37	79	22	20	5	2	22	0	150
38	74	20	16	1	7	49	0	167
39	86	24	17	10	9	32	0	178
40	87	22	21	4	7	20	0	161
41	67	11	20	2	5	7	0	112
42	102	20	30	6	6	34	0	198
43	62	13	15	2	3	108	0	203
44	73	9	15	0	4	26	0	127
Total	2552	604	639	208	153	1261	0	5417

*Bulls were not differentiated to maturity, therefore all bulls were placed in the young bull class.

Appendix J. Summary of Bathurst spring classification counts, 21-22 March, 1994.

		Calves		Yearlings		Bulls			
Group	Cows	♂	♀	♂	♀	Young	Mature	Total
March 21								
1	47	12	12	7	7	28	0	113
2	28	10	6	5	1	25	4	79
3	21	3	3	2	1	6	3	39
4	49	6	5	3	2	6	2	73
5	99	13	11	9	7	14	9	162
6	66	12	7	5	8	14	0	112
7	58	9	8	1	1	7	9	93
8	49	5	3	2	1	6	1	67
9	46	1	8	2	2	8	0	67
10	19	5	2	3	3	6	0	38
11	47	4	1	5	0	10	4	71
12	15	2	2	3	2	15	14	53
13	84	9	10	10	7	34	12	166
14	67	8	16	15	3	14	8	131
15	71	8	18	10	5	34	11	157
16	28	6	3	5	2	9	1	54
17	35	6	5	8	2	12	7	75
18	58	6	12	5	3	21	27	132
19	67	14	20	5	6	13	2	127
20	111	22	15	3	6	29	4	190
21	58	14	3	9	5	18	12	19
22	94	14	13	8	7	23	3	162
23	73	5	9	4	1	5	3	100
24	61	8	7	5	2	12	2	97
25	219	20	26	11	8	22	1	307
26	31	6	4	2	1	6	0	50
27	100	7	5	4	2	7	3	128
28	66	3	10	5	0	5	2	91
29	24	3	4	6	1	3	2	43
30	21	6	6	3	2	9	0	47
31	64	9	7	2	4	25	4	115
32	43	2	5	3	1	6	6	66
33	42	7	8	2	1	11	0	71
34	54	12	6	3	3	13	1	92
March 22								
35	32	3	10	3	1	14	57	120
36	9	3	3	2	0	33	115	165
37	5	3	3	2	0	37	102	152
38	15	5	2	3	1	43	79	148
39	7	1	2	3	0	14	101	128
40	40	31	22	11	1	62	31	198
Total	2166	323	322	199	110	679	642	4420

Appendix K. Summary of Bathurst spring classification counts, 6-7 March, 1995.

		Calves		Yearlings		Bulls		
Group	Cows	♂	♀	♂	♀	Young	Mature	Total
March 6								
1	0	1	0	0	0	0	19	20
2	0	1	0	0	0	0	34	35
3	34	17	8	6	1	25	2	93
4	37	1	3	2	1	6	0	50
5	69	7	9	6	1	18	6	116
6	28	6	5	0	3	2	4	48
7	66	11	16	5	2	28	2	130
8	59	13	21	1	2	14	4	114
9	36	11	8	4	2	8	0	69
10	46	8	22	3	1	17	2	99
11	36	33	18	10	4	23	0	124
12	17	9	4	4	3	6	2	45
13	30	6	12	0	2	10	1	61
14	34	16	14	4	2	10	0	80
15	33	18	13	7	4	31	2	108
16	53	23	26	5	3	32	2	144
17	32	12	15	1	0	17	1	78
18	19	13	5	1	3	4	2	47
19	30	6	5	3	1	7	0	52
20	22	5	2	0	2	8	7	46
21	45	19	20	2	0	31	4	121
22	25	6	6	1	1	1	1	41
March 7								
23	42	13	14	7	3	11	0	90
24	26	6	6	2	2	4	6	52
25	33	8	5	0	2	7	4	59
26	36	6	9	3	2	4	1	61
27	28	6	8	4	1	7	0	54
28	47	12	11	1	2	6	0	79
29	83	4	4	1	1	12	4	53
30	83	14	21	0	4	9	7	138
31	70	4	8	2	6	5	1	96
32	31	11	4	0	3	6	0	55
33	70	11	20	2	4	5	2	114
34	87	14	14	1	6	10	1	133
35	78	9	10	1	1	17	1	117
36	95	17	15	0	2	7	4	140
37	33	4	8	1	0	2	2	50
38	43	10	3	2	3	5	1	67
39	60	18	16	0	5	6	3	111
Total	1640	409	408	92	85	424	132	3190